ORIGINAL.

STUDIES ON THE ENDEMIC FLORA OF INDIA AND BURMA.

(THESIS PRESENTED FOR THE Ph.D. DEGREE OF EDINBURGH UNIVERSITY. 1939)

D. CHATTERJEE.

CONTENTS.

Studies on the endemic flora of India and Burma.

I. Introduction:-

The present work was undertaken at the suggestion of Professor Sir William Wright Smith in October 1937, for the Ph.D. degree of Edinburgh University. No recent detailed and complete analysis of the Indian and Burmese floras from the point of view of their endemic contents, has been undertaken by workers on Botany; those who have attempted partial research in this direction have produced data of too fragmentary a nature to permit of a general view upon the subject. In the past Sir J.D. Hooker, in his Introductory Essays to the Flora Indica (1855), and subsequently in that section of the Imperial Gazetteer of India (1909), which is given to Botany, divided the Indian Empire into several Phyto-geographical regions. His knowledge of the Indian flora was profound and his division of the area was, and still is, very satis-:factory. C.B. Clarke in Journ. Linn. Soc. XXXIV. (1898), attempted a somewhat different classifica-:tion of the Indian Floral regions on a more statistical basis, following the distribution of Cyperaceae in India. H.G. Champion, in a recent publication (Indian Forest Record, 1936) has endeavoured /

endeavoured to indicate the general vegetation types of the country from the different viewpoint of climatic relations. Taking all these works into consideration, in the present paper I have outlined a modified method of dividing the Indian area. I do not claim that my principles of division are final, nor is it to be expected that unanimity of opinion is to be secured on the subject, when the vast area of the country with its much diversified vegetation presents so many problems and difficul-:ties of so varied a nature.

Since the publication of the first volume of Hooker's Flora of British India in 1872, about seventy years ago, constant additions of new species and of new records of known species have been made to the flora of the country. Species of earlier botanists have been broken into several smaller specific units and many have been reduced or interpreted differently in later monographs. These records have been published in hundreds of different journals of many countries and to-day there is no single publication containing an up-to--date list of Indian Plants; and so, as a prelimin-:ary to further study it was decided to make a complete list of Indian species showing their present distribution. It might be expected that in

drawing /

drawing up a list of this kind*, where an accurate record of the identity and distribution of each species is an absolute necessity, difficulties of various kinds would be encountered. Thus the question of whether a particular plant is endemic in India or not, can only be settled by looking up all available records of the countries that surround India. Hundreds of species and scores of genera which seemed endemic in Hooker's time have now been found widely distributed in Siam, Malay, and the Philippines, so that they can no longer be reckoned as endemic in India. Consequently it has been necessary, completely to revise the records of distribution published in the Flora of British India and other periodicals. All accounts of re-:cent collections on the Burma-Yunnan and Burma-Tibet frontiers and in the Tibetan-Himalayan regions have /

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*The list or catalogue shows the distribution of Indian Dicotyledons in different phyto-geo-:graphical areas, and outside India in the surround-:ing countries (when they occur). The families and genera have been arranged as in the Flora of British India of Hooker and the species are arranged alphabetically. The catalogue has been carefully compiled and incorporates all new species described till the end of 1935. Modern nomenclature has been followed and used as far as practicable and every available publication has been consulted for this compilation, though absolute accuracy is not claimed. It has been also necessary to make a large number of new combinations.

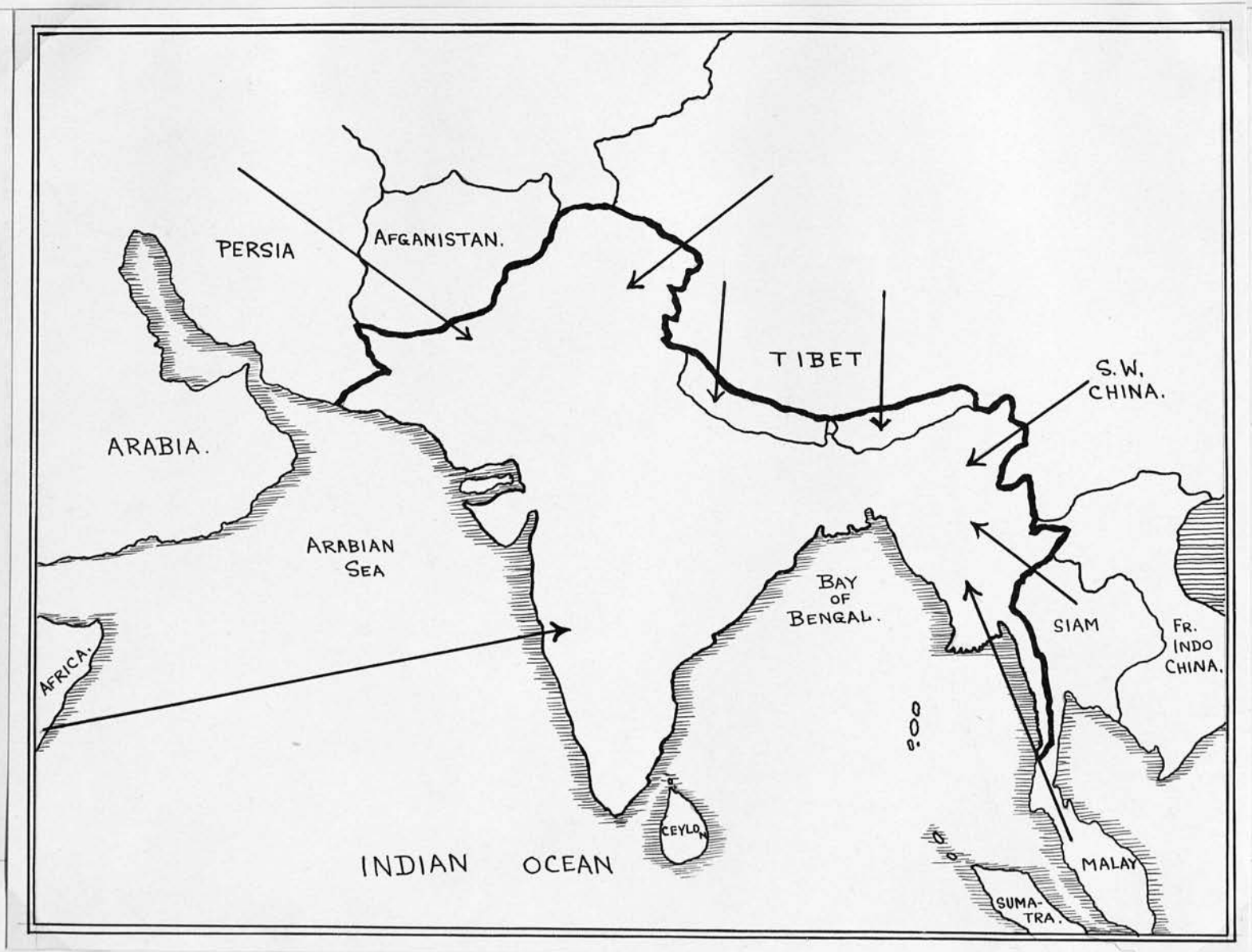
been consulted, as well as "Flora siamensis Enumeratio" by Craib and "Symbolae Sinicae" by Handel-Mazzetti, all of which have helped to throw much light upon the Indo-Chinese floristic elements in the Indian area.

At the same time genera and species which occur just outside the boundaries of India proper as well as many in Malaya, Sumatra, Java, and Ceylon have had to be excluded, though they may have been recorded in the Flora of British India. None the less, the great influence of these countries upon the flora of India is evident although the vegeta-:tion of most of these regions is very different from that of India; - for example Ceylon, though so close to India contains a very high percentage of endemics of its own.

In making a list of species for the catalogue I have had to restrict myself to Dicotyledons which in themselves form a vast assemblage. Having com-:pleted the catalogue, and using the information it afforded, I have endeavoured to draw up in some detail an account of the endemic elements in the Indian flora and an estimate of the influence of the different floras of the surrounding countries upon that of India, by a study of those genera and species which seem to furnish significant data.

II. India and the surrounding countries.

The surrounding countries which have contri-:buted to the Indian flora (shown in the catalogue under column "Outside India") are, Ceylon, Burma, Malay - (with Sumatra, Java, Borneo, and the Philip-:pines), South West China (which is taken to include the western provinces of China with Siam and French Indo-China), Tibet, Eastern China and Japan, Western Asia (including Afghanistan, Persia, Arabia and eastern part of Mediterranean region) and finally Africa (with Madagascar). A large number of species have come to India from these surrounding countries. From them certain families can be readily marked out as supplying many introductions to India - e.g. the Majority of the Cruciferae and Caryophyllaceae from the Mediterranean region; Dipterocarpaceae and probably Ternstroemiaceae from Malayasia; Papaveraceae and Fumariaceae from North Asia; while the majority of Capparidaceae and Ancistrocladaceae suggest an influx from Africa. The following map of S.E. Asia shows the probable routes of immigrants. (Map No. 1). Page 6.



MAP NO. 1.

MAP SHOWING INDIA AND SURROUNDING COUNTRIES.

III. Plant Geographical regions of India.

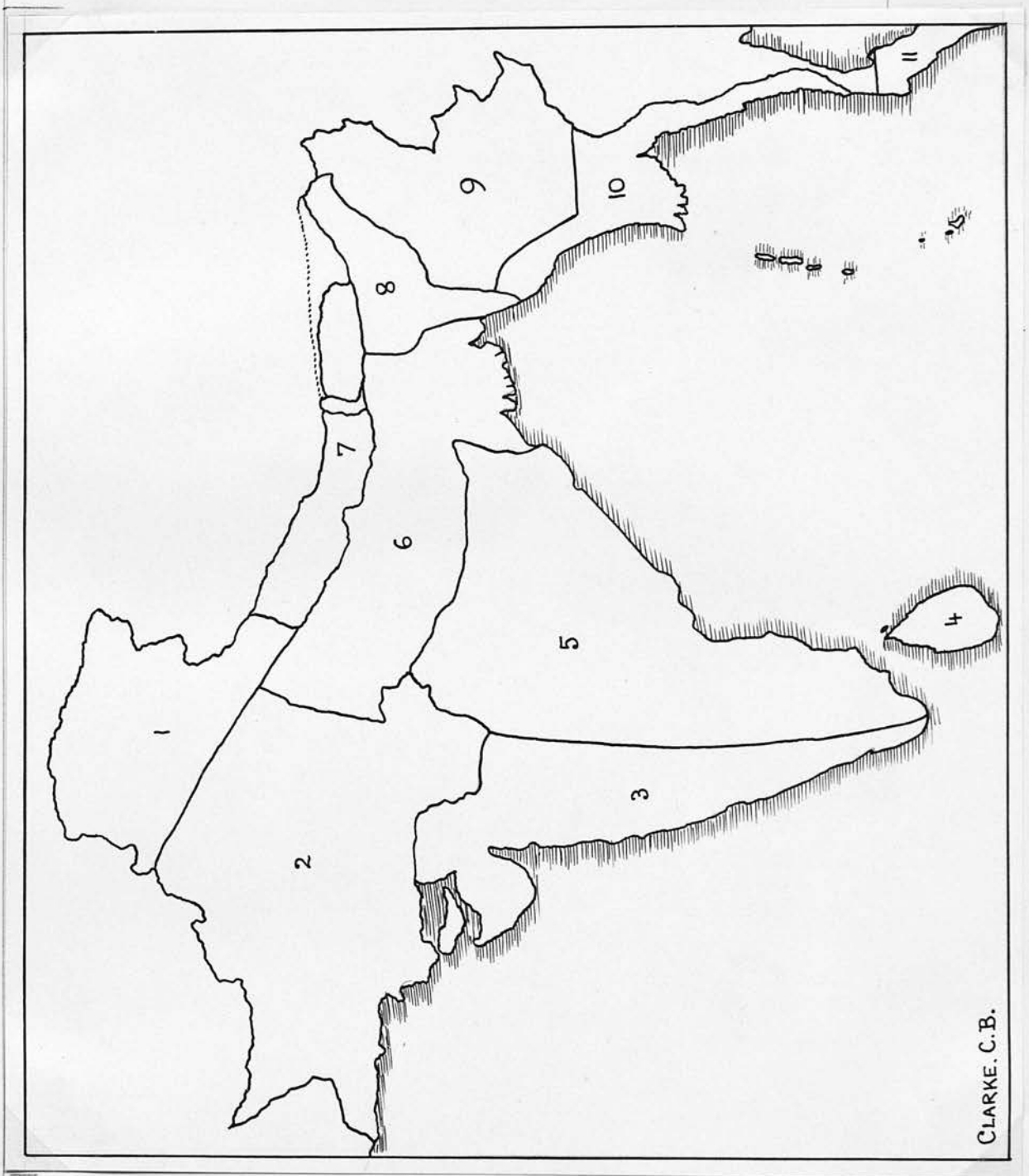
I have divided India as is shown in the cata-:logue into eight Phyto-geographical regions: the Deccan comprising the major part of Madras, Hydera-:bad and Mysore; Malabar consisting of the major part of the Bombay Presidency and the state of Travancore; the Indus plain - subdivided into the dry desert region of Sind, Rajputana and part of Beluchistan and the humid region of the Punjab; the Gangetic Plain with an upper dry region extend-:ing from the Punjab over the greater part of the United Provinces as far east as Allahabad, and a lower humid region including the rest of the United Provinces, Bihar and Orissa, and Bengal excepting the areas in the Gangetic delta which form the next subdivision the Sundarbans; Assam; Eastern Himalayas including the Danjeeling district of Bengal, Sikkim and Bhutan and extending to the Mishmi Hills; Central Himalayas - Nepal; and, Western Himalayas extending from the Kumaon Hills through Kashmere to the North West Frontier Province.

As already stated this arrangement differs somewhat from those proposed by Hooker and by Clarke, which, along with the modified arrangement now suggested, are set out in the following table. The numbers in brackets before the name of each region indicate /

indicate the sequences followed by respective authors, which are also retained in the following maps.

Clarke, C.B.	Hooker, J.D.	Present writer
(1) West Himalaya	(2) Western Himalaya	(8) Western Himalaya
(2) India Deserta	(3) Indus Plain	(3) Indus Plain
(3) Malabaria	(5) Malabar	(2) Malabar
(4) Ceylon	(7) Ceylon & Maldives	X
(5) Coromandalia	(6) Deccan	(1) Deccan
(6) Gangetic Plain	(4) Gangetic Plain	(4) Gangetic Plain
(7) East Himalaya	(1) Eastern Himalaya	(6) Eastern Himalaya
(8) Assam	X	(5) Assam
X	X	(7) Central Himalaya
(9) Ava	(8) Burma	(9) Upper Burma
(10) Pegu		(10) Lower Burma
(11) Malay Peninsula	(9) Malay Peninsula	X

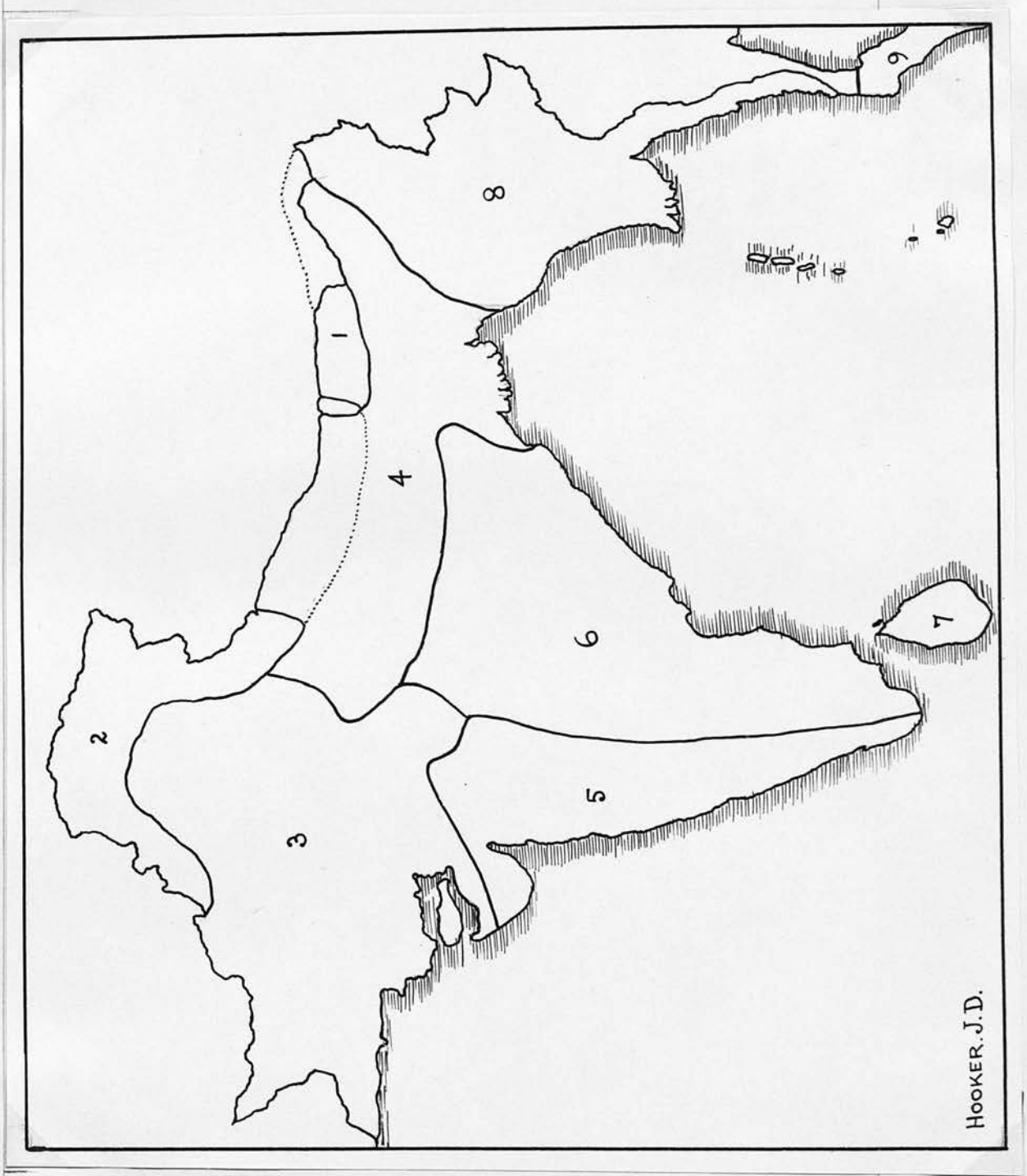
The limitations of the various regions defined by Hooker, Clarke and myself are shown in the three accompanied maps. (Maps 2, 3, & 4).



MAP NO. 2.

MAP SHOWING DIVISIONS OF INDIA PROPOSED

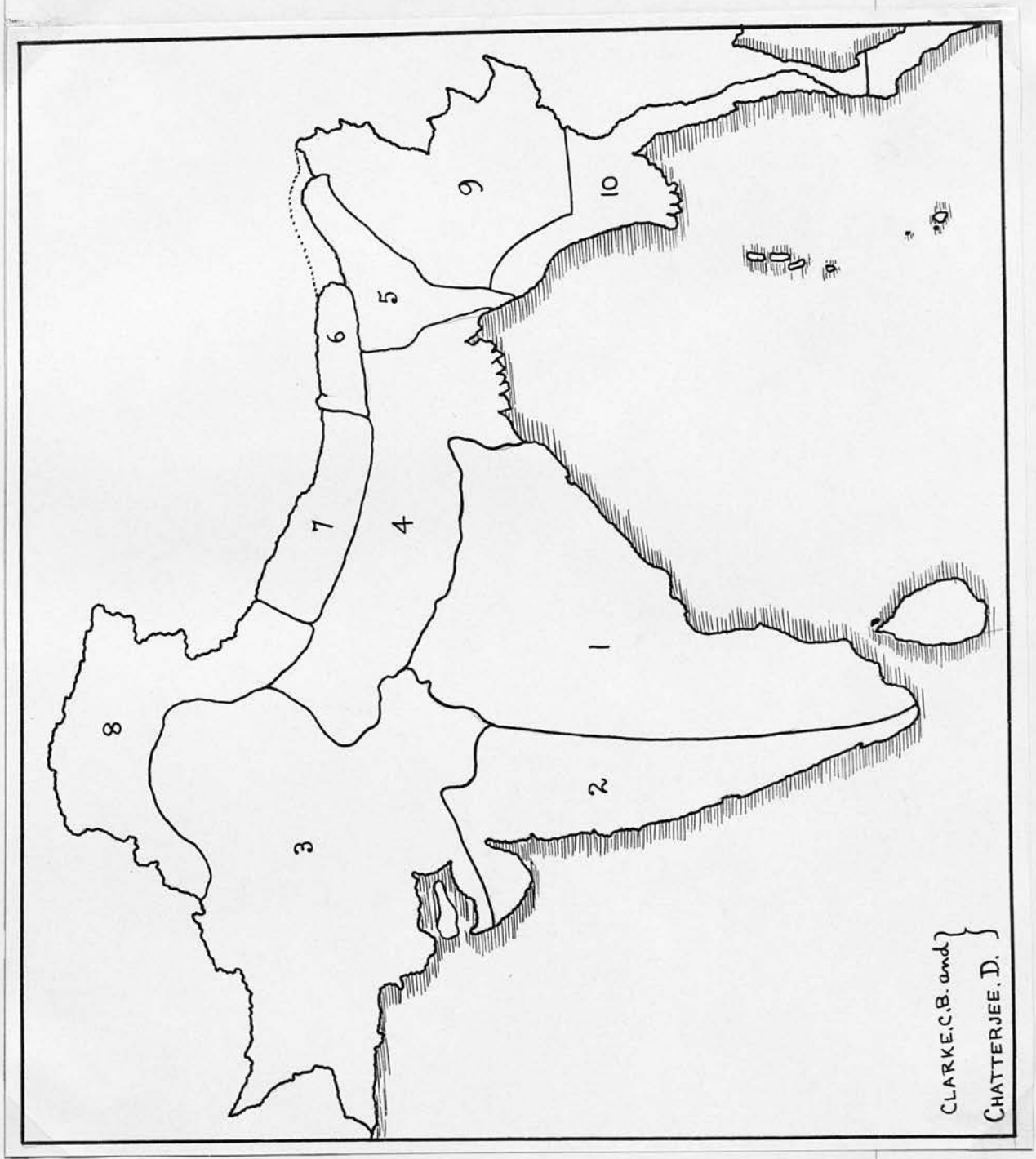
C. B. CLARKE. (1898).



MAP NO. 3.

MAP SHOWING DIVISIONS OF INDIA PROPOSED

BY J. D. HOOKER. (1909).



MAP. NO. 4.

MAP SHOWING DIVISIONS OF INDIA PROPOSED IN A MODIFIED WAY BY THE PRESENT AUTHOR. (1939).

The reasons for the modifications which have been made in the last map are as follows:-

(i) In the first place Hooker and Clarke both included Ceylon and Malaya, but since these regions have floras which are distinctly foreign to that of India, they have been excluded from my review.

(ii) Secondly, whereas Hooker includes the province of Assam in the Gangetic Plain, here, following Clarke it is excluded and considered as a separate region because of its distinctive flora.

(iii) Thirdly, I have divided the Himalayas into three regions keeping Nepal - the Central Himalayas, as a separate region.

(iv) Moreover I have somewhat altered the sequence of the areas taking the Deccan and Malabar first in consideration of the older geological age of these areas in comparison with the Himalayas.

IV. Inter-relationship of the Indian regions:-

In a continent as large as India it will be remarkable to find great uniformity in the distri-:bution of species; actually the vegetation in different regions is very diverse. That of the Deccan, Central India, Rajputana and the Western Himalayas, contrasts with that of Malabar, Lower Gangetic Plain, Assam and Lower Burma and the striking floristic differences between these regions can in the main be explained by variation in rain-:fall and humidity, though factors of soil and altitude must also be taken into account. Reference to any rainfall map of India will show that whereas the rainfall is very high in Malabar, Assam, and Lower Burma, it is on the contrary very low in Hyderabad, Rajputana, Sind, and the Western Himal-:ayas. Broadly speaking this corresponds, on the one hand, to a vast arid area where the vegetation is comparatively uniform with Acacia arabica as the dominating plant, forming with associated species a scrubby or thorny growth; and, on the other hand, to a wet area, where tropical forests with most luxuriant growth and with species occurring in great mixture, must be regarded as the climax community. Within this wetter area there is less uniformity of species than in the drier /

drier zone and this is well illustrated by the distribution of certain groups of plants and prom-:inent species. As an example Dipterocarpaceae may be cited, where the distribution of different species is determined by comparatively small varia-:tion of rainfall. Here species belonging to the same family and sometimes to the same genus show striking contrast in their habit and behaviour. In the genus Dipterocarpus itself there are two groups - species which favour a drier environment such as D. obtusifolia, Teysm. and D. tuberculatus, Roxb., and others which are of a more hygrophilous type such as D. turbinatus, Gaertn. f., D. indicus, Bedd., D. pilosus, Roxb., and D. alatus, Roxb. In general, these two groups show further contrast in that the xerophilous species almost always occur gregariously and are deciduous, while the hygrophilous species occur sporadically and are evergreen.

On the contrary with its limited distribution, the Sal (Shorea rubusta, Gaertn. f.) seems to be less directly influenced by rainfall than by other factors, for it is the typical plant over a large tract of country where the rainfall is by no means uniform. There are two main centres of development of this species. First in the foothills of the Himalayas where it extends in almost unbroken succession /

succession from the Kangra Valley in the east Punjab to the Darrang district of Assam, and the second region in central India extending from the Southal Parganas southward to Chota Nagpur reaching the Ganjam district of the Madras Presidency. It is noteworthy that in the Gangetic Plain which separates these two regions Sal is entirely absent - and this can only be explained by factors of climate and soil.

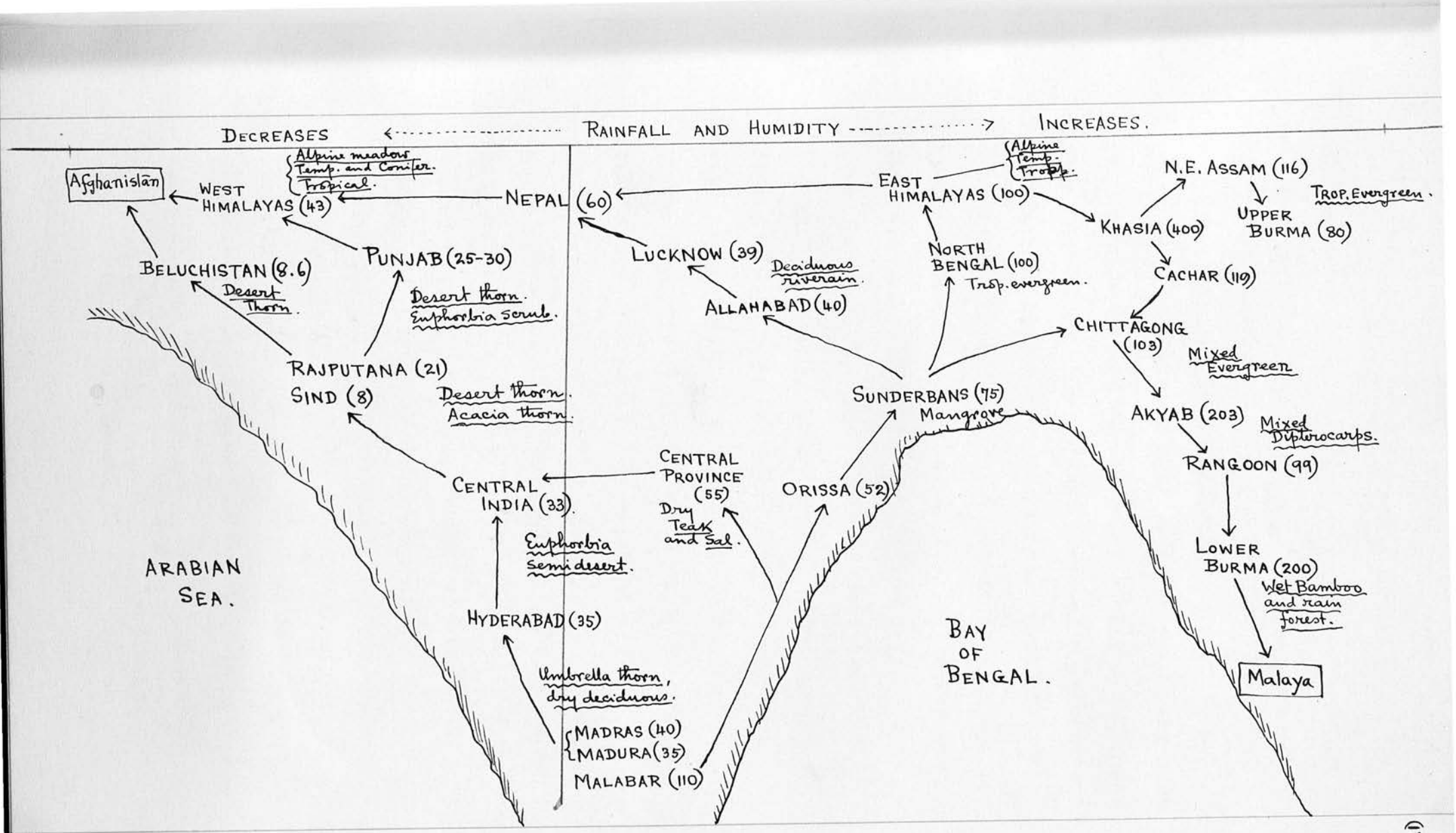
In the hilly or mountainous regions - the Himalayas, the hills of Khasia, Burma and the Nil-:giris, altitude is of course the dominating factor in determining the vegetation. It may be remarked that although these regions are widely separated the vegetation of the upper subtemperate regions is closely similar in all. In every instance the lower zone is characterised by rainforests - com-:posed of a large number of species occurring in mixed association, but in the Himalayas with a marked contrast between the drier western side with a sparse vegetation and the central and eastern side, where the growth is more luxuriant. In the higher zone, Cedrus deodara and Pinus excelsa dominate in the west and Pinus khasya is the ruling species in similar levels in Assam and the Naga Hills. A zone of Oak and Chestnut forest with Magnolias and laurels ranges from 8 to 10,000 feet with /

with conifers in small patches, and above this Rhododendron forest to 12,000 feet leads to the upper alpine meadows where only shrubs and herbac-:eous plants survive.

To summarise the facts and to explain the relationships of the main vegetational types as they occur in various regions of India with differ-:ent rainfall, the accompanied diagram is given. (Name of each place is followed by a number in bracket indicating the total annual rainfall in inches.) See diagram on page 17.

Emphasis has been laid upon the diversity of the vegetation of different areas; at the same time it may also be remarked that certain species are very characteristic of certain areas. Some genera and species are very localised, others have a wide distribution.

An attempt to observe how far the distribution of plants from outside India has influenced the original flora of the country, leads us to the question of endemism; but before going into detail of the endemic and non-endemic elements of the Indian flora, the subject of endemism will be discussed first in the following lines from a more general point of view.


DECREASES ← RAINFALL AND HUMIDITY → INCREASES.
Afghanistan
WEST HIMALAYAS (43)
Alpine meadow
Temp. and Conifer.
Tropical.
NEPAL (60)
EAST HIMALAYAS (100)
Alpine
Temp.
Tropic.
N.E. ASSAM (116)
Trop. Evergreen.
UPPER BURMA (80)
KHASIA (400)
CACHAR (119)
BELUCHISTAN (8.6)
Desert Thorn.
PUNJAB (25-30)
Desert thorn.
Euphorbia scrub.
LUCKNOW (39)
Deciduous riverain.
ALLAHABAD (40)
NORTH BENGAL (100)
Trop. evergreen.
CHITTAGONG (103)
Mixed Evergreen
RAJPUTANA (21)
SIND (8)
Desert thorn.
Acacia thorn.
SUNDERBANS (75)
Mangrove
AKYAB (203)
Mixed Dipterocarps.
RANGOON (99)
CENTRAL INDIA (33)
CENTRAL PROVINCE (55)
Dry Teak and Sal.
ORISSA (52)
Euphorbia semi desert.
LOWER BURMA (200)
Wet Bamboo and rain forest.
ARABIAN SEA.
HYDERABAD (35)
BAY OF BENGAL.
Malaya
Umbrella thorn, dry deciduous.
MADRAS (40)
MADURA (35)
MALABAR (110)

V. Endemism.

General treatment:-

A. The word endemic is generally used to mean a species, genus, or other group confined to a small area. In recent years species which are con-:fined to comparatively large areas are also spoken of as endemics. The endemic state of a species or of a genus is variously described. Some hold the view that endemic species or genera are the survi-:vals of the larger groups of the past which are now in course of gradual extinction while others maintain that they are new and recent forms of gradually extending plant-groups. The supporters of the former view put forward the examples of Tree ferns, and Ginkgo biloba which are endemic in their respective regions, while those who support the latter view would cite examples like the numerous endemic species of Impatiens, Primula, Rhododendron, and Gentiana. It is possible that both schools are correct in their views, but from the evidence of the large number of new forms, continually arising by natural crossing and muta-:tion it is quite likely that the latter view has more supporters.

The main factors responsible for the produc-:tion of endemic species are mutation and natural crossing amongst closely allied plants growing in a favourable locality. The effect is further enhanced by /

by the removal of outside influence which in other words means the creation of a state of "isolation." The vegetation of Oceanic island is a good example, for there a large percentage of the flora is endemic. For example, 82 percent of the species in Hawaii Islands are endemics, 72 percent in New Zealand and 50 percent in Fiji Islands. The high percentages of endemic species in each of the above groups of islands have been produced in great measure by their isolation. Some parts of Continent-:al areas often show a high degree of endemic contents, and it may be found that these areas also present special forms of isolation. The most usual forms of these are either a lofty mountainous chain or a very dry region (desert etc.), separating two land areas. A typical example is the Himalayan range - a very interesting area with high percentage of endemic species. This range has the warm alluvi-:al plains of India to the South and the dry Tibetan plateau to the North. Consequently the species that compose the temperate, and the alpine vegetation of the Himalayas have freely formed new species within this area, but these have been unable to migrate freely, either north or south. This physical isolation in a continental area as shown by the Himalayan range has produced endemism in various parts, as is shown by the following diagram:-

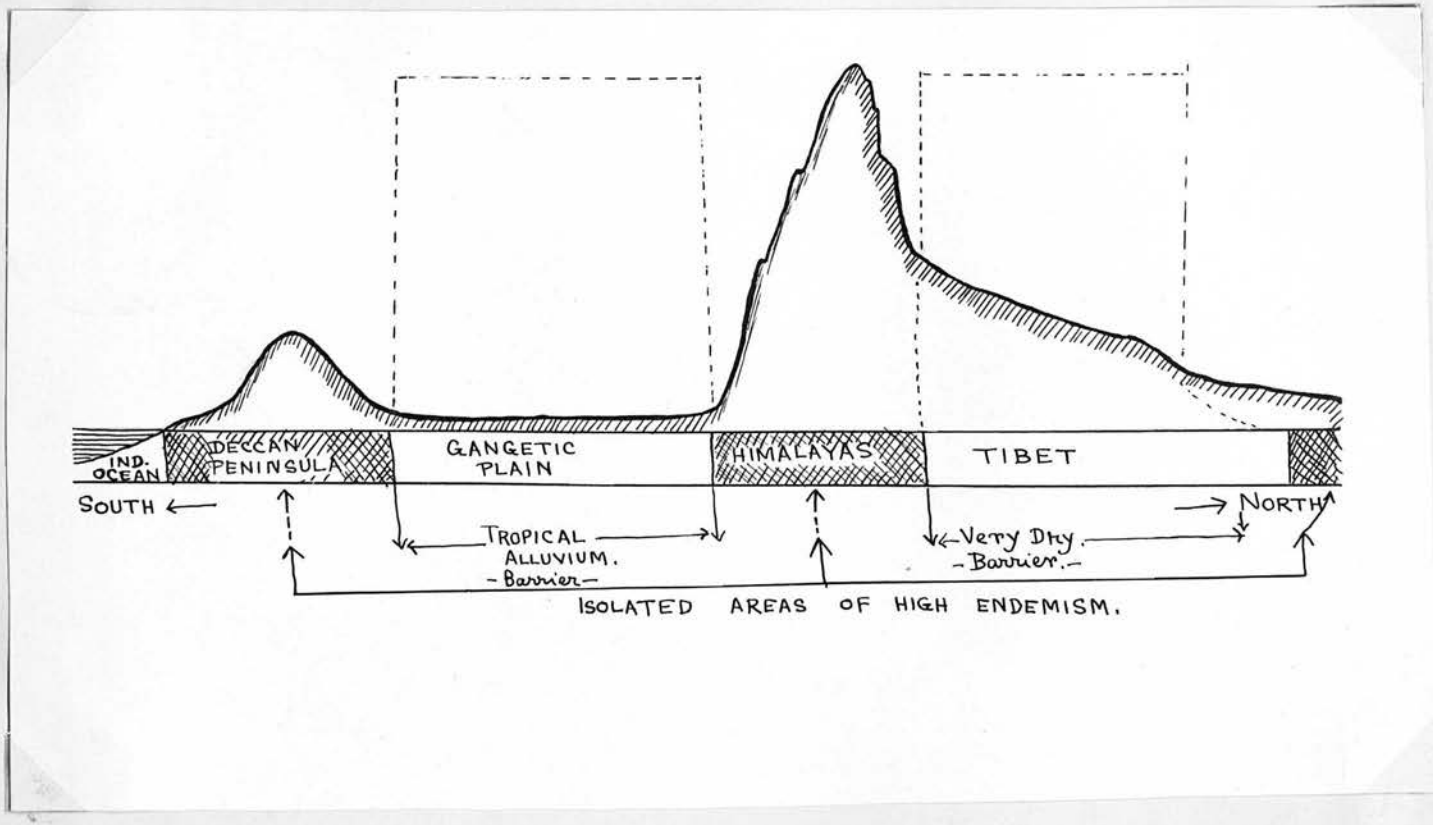


DIAGRAM SHOWING HOW THE BARRIERS OF TIBET AND GANGETIC PLAIN HAVE INDUCED ENDEMISM IN SOUTH INDIA AND THE HIMALAYAS.

It is probable that the distribution of endemic species give some indication of their age. Willis in his "Age and Area", proposes the theory that all endemic species which occupy a smaller area are to be regarded as younger species - a point of view which seems to be correct for a large number of species, but certainly not for all. In other words, he emphasises that the frequency of a species over an area varies directly with its age in evolution. He has further supplemented his statement by the following figures of endemic species from Ceylon:-

Common in the whole area -	90
Rather common	139
Rather rare	136
Rare	192
Very rare	233

Somewhat similar figures for the Indian area have been worked out by me and they seem to favour Willis' view.

Number of endemic species Common generally in India -	533
Number of endemic species in the Himalayas only -	3165
Number of endemic species in Continental India -	2045
Number of endemic species in Burma -	1071

From the above two sets of figures for

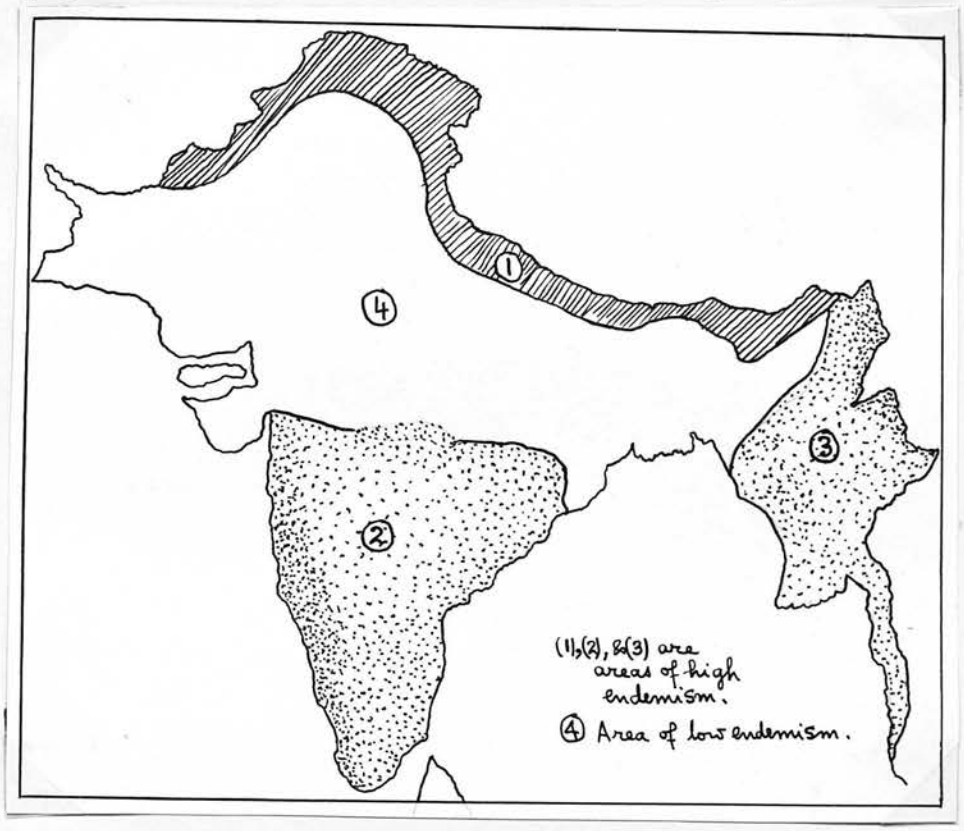
Ceylon /

Ceylon and India it seems very reasonable to regard endemic species as new forms, produced from a stock capable of change. These new forms, not having had the opportunity or the time for migra-:tion are thus localised, and are not found over an extended area. This seems to be a possible general explanation of endemism in plants and the view of "relic" or "survival species", although true for some plants, may have much less signifi-:cance in the general theory.

B. Endemism in India.

As India is a part of the largest continent in the world, its general flora has been influenced by the widely separated countries that surround it. An approximate estimate of the Indian Dicotyledons shows that 61.5 percent of the plants are endemic. This figure is definitely very high for a continent-:al area with land connections in three directions, east, north, and west. In India there are three regions containing a specially large number of endemic species and these jointly contribute to this high percentage for the whole country. These regions are (i) The Himalayas, (ii) The Indian Peninsula forming "Continental India", and (iii) Burma. The rest of India - the Indo-Gangetic plains and the desert regions of Sind, Rajputana and /

and the dry regions of Beluchistan, - form an area which is extremely poor in endemic content. The variation of the intensity of the endemic population is shown in the following map.



It is clear from the map that the Northern part of India is completely occupied by the lofty mountains of the Himalayan range. The effective nature of this as a barrier to plant-migration has already been pointed out. This barrier is separated from Continental India by a broad and dry plain which has cut off that region from close contact with the northern flora, thus affording a large independant area with a high endemic population. /

population. The Deccan Peninsula contains no less than 2045 endemic species and is thus not far behind the Himalayas with 3169 endemic species. How far land connections between Malayasia, India, and Africa have influenced the present flora of the Deccan Peninsula is difficult to indicate with any degree of precision.

Burma is another region very rich in endemic contents. It is connected on three of its sides with other countries and inter-migration of its flora has taken place. Non the less the outside influences are not too manifest in the Burmese flora. There are two main tendencies of immigration into Burma - a Chinese one from North East which will concern chiefly temperate and alpine plants and a Malayasian influence from South East bringing in a more tropical flora. In spite of these foreign immigrants as many as 1071 species are localised in Burma.

In its comparatively high endemic percentage for a continental region India (with 6850 endemic species, 134 endemic genera and 61.5 percent endemic flora) may be compared with the following countries.

Countries.	Total sp.	Percentage of endemism.	Number of endemic genera.
Ceylon	800	30%	23
New Zealand	1000	72%	32
Australia	7500	80%	470
Hawaii Is.	600	82%	45
California	1416	40%	not available.

The total number of species recorded from India with the number of "Wides" and the proportions of endemic species in different regions is shown by the following table.

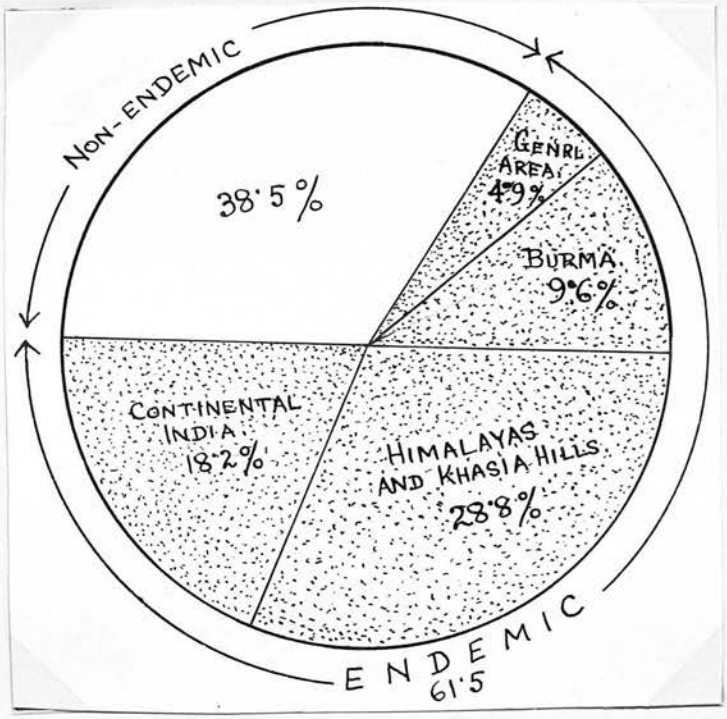
Total sp.	Total Genera.	Wides.	Endemics. Cont. India.	Himal with Assam.	Burma.	Gen. Area.
11,124	1831	4274	2045	3169	1071	533
Percentage		38.5	18.2	28.8	9.6	4.9

38.5 + 61.5 = 100

Note - The total figure includes about 32 species of doubtful nature or of which exact localities are unknown (being referred as only from India.)

This /

This is expressed diagrammatically as



The endemic percentages of these three areas (i.e. Continental India, Himalayas and Burma), if calculated on the basis of each area and not on India and Burma as a whole, would obviously be very much higher. They would range from 50% to at least 70%, the higher ration being undoubtedly in the Himalayan region. This would however mean a much more elaborate calculation.

VI. Non-endemic elements in the Indian Flora.

As has already been stated there are 38.5 percent of the total plants in India which occur as "Wides." This means they are found in other countries also. These non-endemics appear to me to fall into the following categories:-

(i) Species chiefly tropical and sub--tropical of fairly wide distribu-:tion in Asia, and sometimes beyond.

(ii) A considerable number of species of limited distribution occurring just beyond the boundaries of our area, e.g. S.W. China, Siam, Tibet and Afghanistan. They can not be reckoned as endemics if we adhere to the geographical boundaries as we must, but in many cases they are very localised.

(iii) Non-endemics associated with cultivation and therefore of wide distribution, as well as certain introduced plants.

Further points arising under this section will be discussed in section VIII where I deal with individual families and genera.

VII. Dominant families and genera of India.

During the last thirty years the addition of species new to the Indian flora has tended to alter somewhat the arrangement made by Hooker in 1909 (Imp. Gazetteer of Ind. Vol. I) where he quotes in sequence the six largest Dicotyledonous families. I give below my summations for these families and have added Hokker's sequence in contrast:-

1. Papilionaceae - 867 species - 1st. in Hooker's arrangement.
2. Compositae - 696 species - 5th. Do. ..
3. Rubiaceae - 551 species - 2nd. Do. ..
4. Acanthaceae - 514 species - 4th. Do. ..
5. Euphorbiaceae - 444 species - 3rd. Do. ..
6. Labiatae - 421 species - 6th. Do. ..

These six families are followed (in accordance with my present figures) by Scrophulariaceae (273), Rosaceae (257), Balsaminaceae (242), Asclepiadaceae (234), Primulaceae (208), Gentianaceae (189), Umbelliferae (180), Cruciferae (178), Convolvulaceae (177), Lauraceae (172).

It will be noticed that the six dominating families of 1909 have remained the same six to-day though three of them have altered their positions. Compositae play a very dominant part in the vegeta-:tion of many countries and Hooker expected that with /

with more records of these from the Indian region the family would take a more prominent position as regards dominance than the 5th place in his own reckoning. To-day we find that Hooker was correct in his anticipation. Papilionaceae exceed Compositae by a wide margin and in a country like India the former will probably always hold the more dominant position. The 3rd place is occupied by the family Rubiaceae, which was second in Hooker's arrangement. One reason for the slight fall in position is perhaps the exclusion of species from Malaya and Ceylon in our estimate, while they were included by Hooker. Even if we had followed Hooker and included all the species of Rubiaceae from these areas it would be difficult to supersede the present high figure of Compositae.

Acanthaceae and Labiatae have maintained their former positions though they have received a significant number of additions during the period of the last thirty years. Other families which similarly have had considerable accessions are Balsaminaceae, Primulaceae and Gentianaceae.

The proportion of genera to species may be expressed as 1 to 6, as contrasted to the previous figure of Hooker as 1 to 7. This decrease in proportion can be easily explained by the fact that a considerable number of new genera have been described /

described which are monotypic or nearly so and also many of the larger genera (e.g. Ipomea, Loranthus etc.) have been broken up into smaller generic units. Approximately 290 genera new to our area have added to what were recorded in Hooker's Flora of British India (For list see Appendix to the Catalogue of Indian Plants).

Easily the biggest genus in India is Impatiens. I give below a list of the 20 genera which have the highest content of species:- Impatiens. L. (241), Primula (162), Strobilanthes, Bl. (152), Rhododendron. L. (126), Eugenia. L.(103), Crotalaria. L. (99), Gentiana. L. (93), Piper. L. (89), Polygonum. L. (87), Ficus.L. (86), Pedicu-:laris. L. (76), Senecio, L. (76), Oldenlandia. L. (75), Begonia. L. (71), Corydalis (61), Euphorbia. L. (61), Astragalus. L. (59), Saxifraga. L. (58), Indigofera (53), Desmodium, Desv (52).

A survey of these large genera appears to show that they represent temperate region families much more strongly than tropical. Secondly almost without exception they are genera of a very wide distribution. Only perhaps one of these genera has an almost wholly Asiatic content and that is Strobilanthes, Bl. It is also interesting to note that none of the families can claim more than one of these large genera with the exception of Papilionaceae which has four representatives.

VIII. Commentary on the endemism, relationship, and other special features of some Indian Families:-

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The Dicotyledons in India are represented by 173 families. They may be arranged in three groups as follows:-

(A) Families containing less than 20 species in each.

(B) Families containing 20 or more species in each, and with a majority (more than 50%) of species Non-endemic or Wides.

(C) Families containing 20 or more species in each, and with a majority (more than 50%) of species Endemic.

A. Following are the families that belong to the first group. (Number within brackets at the end of each name indicates the total number of species in India):-

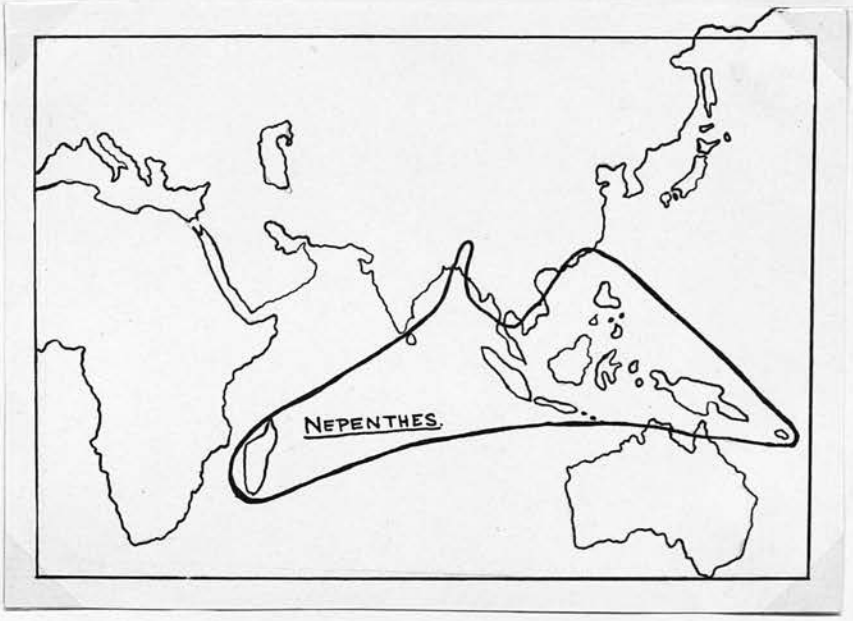
Dilleniaceae (15), Schizandraceae (5), Lardizabalaceae (5), Nymphaeaceae (11), Resedaceae (4), Bixaceae (1), Cochlospermaceae (1) Pittosporaceae (8), Xanthophyllaceae (7), Frankeniaceae (1), Partulacaceae (6), Tamarisc-:aceae (8), Elatinaceae (6), Ancistrocladaceae (5), Linaceae (8), Erythroxylaceae (6), Malpighiaceae (17), Zygophyllaceae (9), Oxalid-:aceae (14), Simarubaceae (15), Ochnaceae (9), Burseraceae (13), Dichapetalaceae (3), Olacaceae (18), Opiliaceae (4), Staphyleaceae (4), Hippocastanaceae (2), Sabiaceae (19), Coriari-:aceae (1), Droseraceae (4), Hamamelidaceae (7), Halorrhagidaceae (14), Rhizophoraceae (16), Hernandiaceae (4), Lecythidaceae (12), Cryptero-:niaceae (3), Sonneratiaceae (5), Passiflor-:aceae (7), Caricaceae (1), Turneraceae (1), Datiscaceae (2), Cactaceae (6), Aizoaceae (16), Alangiaceae (6), Cornaceae (12), Nyssaceae (2), Dipsaceae (17), Stylidaceae (3), Goodeniaceae (2), Monotropaceae (3), Diapensiaceae (1), Plumbagin-:aceae (8), Styracaceae (9), Salvadoraceae (5), Menyanthaceae (1), Polemoniaceae (1), Hydrophyll-:aceae (1), Pedaliaceae (4), Plantaginaceae (13), Nyctaginaceae (8), Illecebraceae (2), Podostem-:aceae (16), Nepenthaceae (1), Cytinaceae (1), Aristolochiaceae (13), Chloranthaceae (3),

Myristicaceae (14), Hernandiaceae (1), Proteaceae (7), Elaeagnaceae (12), Santalaceae (15) Balanophoraceae (6), Buxaceae (6), Ulmaceae (16), Cannabinaceae (2), Platanaceae (1), Juglandaceae (4), Myricaceae (1), Casurinaceae (1), Ceratophyllaceae (1).

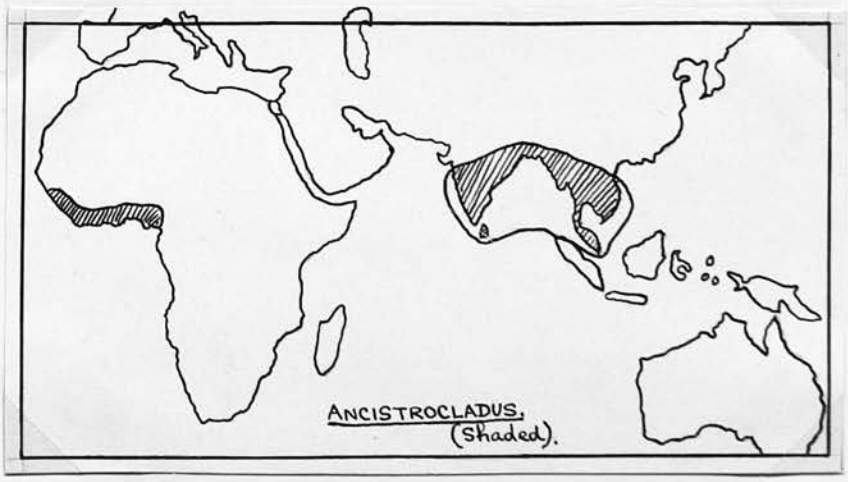
This group contains 81 families. Most of them consist of species which have a wide distribution and do not invite any special explanation. Some of them are interesting from the point of view of distribution, and the main features are as follows:-

(i) Dilleniaceae, Pittosporaceae and Proteaceae have their greatest development in Australia, and their presence in India along with such families like Halorrhagidaceae, Myristicaceae, and partly Santalaceae, clearly point to the Malayasian and Australian influence in India.

(ii) The distribution of Nepentheceae in Assam is the northernmost limit reached by the genus. As has been pointed out by Hitchinson (Fam. Fl. Plants. Dicot. 105), the range of distribution of this remarkable genus indicates a certain relationship between the island of Madagascar and Malayasia through Ceylon and Khasia Hills. The following map shows the distribution of Nepenthes (after Hutchinson).



The genus Ancistrocladus, Wall. which has now been raised to the rank of a family (being separated from Dipterocarpaceae) has an interesting distribution in West Africa and India shown in the following map.



These two cases are prominent among the comparatively few examples of close association of India with the African flora.

(iii) A third set of Families consists of Rhizophoraceae (Mangrove), Sonneratiaceae (Mangrove), Nympheaceae (water plants) and Ceratophyllaceae (water plants), whose wide distribution is explainable from the nature of their environment and special adaptations for distribution through water currents. It is inter-:esting to note that although Rhizophoraceae are represented in India by 16 species, of which 15 are found elsewhere in Malayasian and East Australian shores, there is one monotypic genus (Blepharistemma, Wall.) which is localised in the small area of Malabar in South India.

(iv) The family Malpighiaceae has its greatest development in South America forming a marked feature amongst the tropical lianes. Its presence in the Indian region with 7 endemic species, and also in Malaya is remarkable. Although a few species are also found in Africa and Madagascar, it is difficult to advance any explana-:tion of the spread of this family in South East Asia.

(v) The family Podostemaceae form another interesting ecological group in India. The species of this family, mostly tropical, are characterised by living only in rushing water and growing on rocks in shallow rivers. The chief centre of distribu-:tion in India is to be found in South India with occasional species in Khasia, in Burma, and in the subtropical part of Eastern Himalayas. The Indian species show a high endemic ratio of the 16 species, only 5 are wides and the rest are endemic, with 9 species endemic in South India alone.

(vi) Families like Hamamelidaceae, Oxalidaceae, Olacaceae, Cornaceae, Dipsaceae, Styracaceae, Elaeagnaceae, though not forming a homogeneous group, clearly show a North-East Asiatic influence. Stryracaceae have really three centres of distribu-:tion of which two are in America. The third line which extends from Japan to Java, touches Burma, Sikkim and Khasia where some of the species and one monotypic genus (Parastyrax, W.W. Smith) have been found. Hamamelidaceae are also distributed from North America through Japan and China until they reach Sikkim, Khasia and Burma. Elaeagnaceae have a much wider distribution throughout the temperate regions from Northern Europe to North East Asia and North America and have just touched the North Indian region.

B. Following families belong to the second group:-

Menispermaceae (42), Violaceae (25), Polygal-:aceae (32), Malvaceae (111), Sterculiaceae (80), Tiliaceae (78), Elaeocarpaceae (42), Geran-:iaceae (28), Rutaceae (71), Aquifoliaceae (34), Sapindaceae (54), Connaraceae (20), Caesalpini-:aceae (124), Mimosaceae (96), Myrtaceae (116), Lythraceae (48), Cucurbitaceae (87), Convolvul-:aceae (177), Solanaceae (58), Scrophulari-:aceae (273), Orobanchaceae (29), Bignoniaceae (31) Verbenaceae (115), Amarantaceae (48), Chenopodi-:aceae (40), Thymelaeaceae (22), Moraceae (113),

This group of 27 families which have most of their species distributed widely contains a few temperate ones of some interest.

(i) It is rather unexpected to find that Violaceae Polygalaceae and Thymelaeaceae (which are generally found in temperate regions) have their species so widely distributed as to put them outside the group of families with greater endemic values. The genus Viola has been recently revised and a large number of Himalayan species are now reported from the Yunnan area, and thus the endemic index of the family has been considerably lowered. The family Polygalaceae is cosmopolitan (except for New Zealand and Polynesia) and has many widely /

widely distributed species. The family Thymelaeaceae occurs both in temperate and tropical regions with its greatest development in Africa. The genus Daphne is represented in the Himalayas and the Khasia with some six species which are all endemic, but the occurrence of widely distributed genera like Thymelaea, Edgeworthia, Wikstroemia and Stellera, has reduced the endemic index of the family as a whole.

(ii) Menispermaceae, Malvaceae, Sterculiaceae, Tiliaceae, Caesalpinaceae, Mimosaceae, Convolvulaceae, Scrophulariaceae (in great part), and Moraceae form a tropical group, with a wide range of distribution and it is to be expected that they do not have a high percentage of endemics in any particular region in India.

In Moraceae the tropical genus Ficus with a large number of species is worthy of some comment, The genus, the tenth largest in our area is represented by 86 species. The chief centre of development of the genus may well be Malayasia and South Burma and the species though found largely in adjacent countries do not travel very far from the Indo-Malayan region.

Another very remarkable family in this group is /

is Myrtaceae, of which the chief centres of development are in Australia and South America. The most important genus found in India is Eugenia (including Syzygium, and Jambosa) with 103 species. They are mostly distributed in Continental India. Species of Eucalyptus are found in the Hill Stations of India which however are all introductions from Australia.

Cucurbitaceae, Solanaceae, Amarantaceae, Chenopodiaceae and partly Rutaceae contain many species which have found their way to India as weeds of cultivation, and subsequent naturalisa-:tion.

The family Aquifoliaceae represented by only one genus Ilex contain 34 species in India. The genus is well known for its wide distribution. Its species are found in North and South America, Asia, Africa and Europe and it is quite natural that most of the Indian species are found also in the adjoining parts of Asia. The endemic percentage of Ilex in India is 38%.

C. The following families belong to the third group:-

Ranunculaceae (163), Magnoliaceae (36), Anonaceae (129), Berberidaceae (35), Cruciferae (178), Fumariaceae (66), Papaver-:aceae (45), Capparidaceae (65),

Flacourtiaceae (21), Caryophyllaceae (107), Hypericaceae (26), Guttiferae (40), Ternstroe-:miaceae (39), Dipterocarpaceae (51), Balsaminaceae (242), Icacinaceae (25), Meliaceae (62), Celastraceae (84), Hippocrate-:aceae (27), Rhamnaceae (53), Ampelidaceae (69), Leeaceae (27), Aceraceae (20), Anacardiaceae (67) Papilionaceae (867), Rosaceae (257), Saxifragaceae (114), Crassulaceae (64), Melastomaceae (127), Combretaceae (52), Onagraceae (39), Samydaceae (20), Begoniaceae (71) Umbelliferae (180), Araliaceae (56), Caprifoli-:aceae (55), Rubiaceae (551), Valerianaceae (20) Compositae (696), Campanulaceae (71), Vaccini-:aceae (68), Ericaceae (146), Primulaceae (208), Myrsinaceae (94), Sapotaceae (32), Ebenaceae (58) Symplocaceae (51), Oleaceae (97), Apocyn-:aceae (89), Asclepiadaceae (234), Logani-:aceae (40), Gentianaceae (189), Boragin-:aceae (145), Lentibulariaceae (30), Gesneri-:aceae (133), Acanthaceae (514), Labiatae (421) Polygonaceae (110), Piperaceae (104), Lauraceae (172), Loranthaceae (73), Euphorbi-:aceae (444), Urticaceae (109), Cupuliferae (64) Salicaceae (44).

There are 65 families in this group. These do /

do not have very much uniformity in their distribution although everyone contains more than 50 percent of species endemic to India. Some families are tropical, others are temperate, some have their allies in the dry Orient, while others are related to the Chinese or Malayasian floras. In view of their high endemison and interesting distributional features the majority of the families of this group need a somewhat detailed account:-

Ranunculaceae:-

The members of this family as represented in India are mostly found in the Himalayas, in Upper Burma and in the temperate regions of the Nilgiri Hills. The main centre of Ranunculaceae is undoubtedly in the north temperate himisphere and so far as the Indian species are concerned, their presence is clearly due to the result of an invasion from the north. The degree of endemicity of certain Ranunculaceous genera is well worthy of consideration and their endemic percentages are as follows:-

Ranunculus .. 36%

Anemone .. 43%

Clematis .. 76%

Thalictrum .. 79%

Delphinium .. 71%

Aconitum .. 90%

The first four have actinomorphic flowers and the last two zygomorphic. Although the percentage in Clematis and Thalictrum is high there would appear to be a marked difference between actinomorphic and zygomorphic forms. It could be argued that the zygomorphic genera show a greater tendency to an evolution of new species while the actinomorphic genera might be regarded as more stable. One cannot however, push this argument too far yet a general tendency would appear to be indicated by the figures quoted. The low percentage of endemicity in Ranunculus may quite well be due to the weedy character of many of its members which would account for a considerable number of "wides" in its composition.

It must be confessed that it is difficult to see why Clematis and Thalictrum should show so high a percentage of endemics, when Ranunculus and Anemone with similar floral structures do not present endemic species to the same degree. It seems quite probable, that besides the weedy nature of Ranunculus as has already been pointed out /

out, there exist other factors, other than actinomorphy, which are responsible for this marked tendency towards specific multiplication in Clematis and Thalictrum.

In considering the distribution of certain genera of Ranunculaceae it is worth recording that Actaea spicata, Linn. and Cimicifuga foetida, Linn. have a very wide range not only in India where they occur in the Himalayas but also in North Asia, Europe and North America. A marked contrast with the above is shown by certain genera of restricted distribution, such as Calathodes, Hook. f. & T., occurring in the Eastern Himalaya and Hupeh and Beesia, Balf. f. et W.W. Smith, found to occur in Upper Burma and the adjoining parts of Yunnan.

Magnoliaceae:-

The Magnoliaceae with a very discontinuous distribution are found in temperate and sub-tropical regions of the world. The main trend of their occurrence extends from the Himalaya, China, Japan to North America and naturally the Indian species are found in the Eastern, and South Eastern part of the country. This discontinuous /

discontinuous distribution of the family indicates its great antiquity; at the same time the evidence of the anatomical structure of the wood of many species and the multiple arrangement of the floral parts support this statement. It is however significant that unlike some old families, Magnoliaceae is full of localised endemic species. For example, all the Indian species of Illicium, Talauma, and Magnolia are endemic and a high endemicity is shown in Manglietia and Michelia, which are 80 and 73 percent respectively. This surprisingly high endemic content in a primitive group like this is rather difficult to explain. A view might be put forward, based chiefly on the effect of their tree habit. The species mostly grow as lofty trees and may live beyond 100 years. It is quite possible that during this period, while a herbaceous group like Ranunculaceae regenerating annually, or at any rate frequently, gets a much greater chance of specific variation in certain of its members, the lofty Magnolia would produce viable seeds only for a limited number of times and is thus handicapped in the creation of new species. This is perhaps one of the causes why the species of this family have remained so very localised while the group itself is very old.

Anonaceae.

An admirable account of the distribution of this family has been made by Hitchinson in Kew Bulletin 1923; 243. The Anonaceae are confined to the tropics, found abundantly in the rainforests of Brazil, Western Africa, Ceylon, South Burma and Malayasia. It has been pointed out that the species of the two hemispheres have a difference in habit. In old world they are usually of a climbing or straggling nature and occur in the dense forests, but in Tropical America they are nearly all shrubby or arboreal and grow on open grassy plains. The genera are mostly localised except for Xylopia found in S.E. Asia, Central and West Africa and South America and Anaxogarea with a disconnected distribution in South East Asia and Brazil.

The Indian Anonaceae are all confined to the tropical parts of the Deccan, Assam, and South--Burma and not a single species is found in the temperate regions of the Himalayas.

Dealing with a tropical family like this, we would expect to find a comparatively low endemic percentage, but 60 percent of the Indian species are endemic. Although members of a widely distributed /

distributed family the relationship of the Indian species of Anonaceae is clearly to be sought with the Malayasian members, as we find in South Burma a great concentration of Anonaceae of Malayasian affinity.

Berberidaceae.

From the point of view of endemism the interesting genera of Berberidaceae are Berberis and Mahonia. The general distribution of these is in the north-temperate zone extending from North Asia, Northern Europe to North America and in some degree to South America. In this family there is a very large number of endemics for 97 percent of the Indian species are not found elsewhere.

Whatever may be the reason for this high figure of endemism, it is one of the largest in the present analysis. It is generally believed that Polypetalous families are less equipped for specific variation than the Gamopetalous group. It is difficult to see why the effects of evolu-:tion or progressive variation, would favourably accelerate only the Gamopetalae and not many members of Polypetalae. It is quite evident that the /

the formation of new species has taken place equally in Berberidaceae as in many progressive Gamopetalous families. This view if further supported by the fact that in cultivation the species of Berberis hybridize very freely.

The general habit of Berberis suggests xerophytic conditions yet in India most of the species are found in the humid central and eastern Himalayas. Very few species are found in the dry N.W. Himalayas. The Indian plants of Berberis and Mahonia are obviously related to the Chinese species of Yunnan and the adjoin-:ing areas, where many species occur.

Cruciferae.

The family is represented in India chiefly in the Western Himalayas and the drier regions of N.W. India. There are a few species in the eastern Himalayas and the plains of India, but the whole of South India lacks representatives of this family except for the cultivated species and a few weeds associated with them. A great development of the members of this family is found in the Mediterranean region and a possible connection with the Indian area can be sought through /

through Persia and Afghanistan. The total endemic percentage is only 56 which however is quite a high figure for a presumed invading family. In some particular genera the percentages are higher and mention can be made of Draba (83%), Cardamine (70%), and Arabis (71%) - practically all high alpines.

Fumariaceae.

This family follows somewhat similar lines of distribution to the Ranunculaceae, Berberidaceae and Cruciferae. The only genus worth comment is Corydalis, which is perhaps best developed in the Himalayan and the West Chinese areas, A map showing the distribution of Corydalis has been made by Hutchinson in Kew Bulletin 1921; 97, which clearly shows its wide range in the northern Hemisphere. The endemic figure of the Indian species is very high for 48 species are endemic out of a representative of 61 which brings the percentage to 79.

Evidence is strong in supporting the view that as a genus the main development of Corydalis has taken place in Central Asia and the Himalayas from where it has migrated east and west. It is however /

however interesting to note that in their Hima-:layan development the genus is stronger in Western dry part.

A somewhat localised genus of the family is Dactylicapnos, Wall (syn. Dicentra, Bookh) which ranges from Kumaon to Khasia and Yunnan.

Papaveraceae.

The only noteworthy genus in this family is Meconopsis, Vig. which has developed chiefly in Nepal, the eastern Himalaya and western China. An excellent monograph of the genus has been made by Taylor (Genus Meconopsis. 1934). In the Indian region we have 26 species (including 2 species of Cathcartia) and all are endemic except one which brings the endemic figure to 96 percent. The development of the genus is very similar to what we find in Corydalis with the exception that the concentration of species is more in the moist eastern Himalaya than in the west. The obvious connection of Meconopsis is with western China.

It is perhaps worth noting that the tropical American weed Argemone mexicana, Linn has estab-:lished itself widely in the Indian plains.

Capparidaceae.

In dealing with a family like this which is mainly tropical and subtropical it is natural to find a wide distributional range and so a smaller endemic figure. The endemic percentage of the whole family as represented in the Indian region is 54. The only genus of any size is Capparis with 38 species.

The association is chiefly with species of the drier regions of the Orient and Africa and to a much lesser degree with the Burmese region where the number of species is comparatively low. The African relation can be stressed on the further point of a high representation in Continental India.

Burma contains two small monotypic genera - Hypselandra, Pax et Hoffman, and Borthwickia, W.W. Smith.

Flacourtiaceae.

This is a tropical family and found widely in South India and Lower Burma. The genus Hydnocarpus, Gaertn. is found in Lower Burma and Malayasia and its species have received attention for their medicinal properties. Sleumer in Bot. Jahrbuch 69. i. (1938) has thoroughly revised this genus /

genus and showed in detail its specific distribu-:tion. The Indian members of the family as a whole are related to the Malayasian group except perhaps the genus Gynocardia. Br which is found endemic in Sikkim, Assam and Chittagong hills.

Caryophyllaceae.

This family follows a similar line of distribution to Cruciferae and the same general statement may be made for it.

Guttiferae.
Ternstroemiaceae.
Dipterocarpaceae.

These three families form a naturally related tropical group with a strong Malayasian tendency.

The genera of the family Guttiferae have a varied distribution. Poeciloneuron, Bedd is endemic in South India while Garcinia. L., Calophyllum, L., Kayea, Wall, and Mesua. L. are found from Tropical Africa to Malayasia. The gen-:eral endemic percentage for the family in India is 50, and most of the "wides" are in Malayasia. This shows that a S.E. Asian influence in main is responsible /

responsible for the Guttiferae in our area.

Ternstroemiaceae probably has two independant centres of development, one in Tropical Asia and the other in Tropical America. It is remarkable that the representatives of this family are almost wanting in Africa and absent from Australia. The endemic percentage of the Indian species is 54 and "wides" are also from Malayasia. The genera do not show any striking features as regards their endemism in our area.

Dipterocarpaceae as a family is confined to tropical Asia and has developed its species in large numbers in two widely separated areas, i.e. Ceylon and Lower Burma. From both, species have travelled into the neighbouring countries. An interesting feature of Ceylon species is their high endemic nature and genera like Doona, Thw (10 sp), Stemonoporus, Thw (15 sp) and Monoporandra, Thw (2 sp) are practically confined to Ceylon. The majority of the genera and species occurring in Ceylon are endemic, so that a few have penetrated into South India. The representative genera of south Burma and Assam are Dipterocarpus, Gaertn., Vatica, Linn., Shorea, Roxb, Hopea and Parashorea, Kurz. While Parashorea is a monotypic genus the other four show a somewhat similar development as regards number of species and approximately the same endemic ratio.

Balsaminaceae.

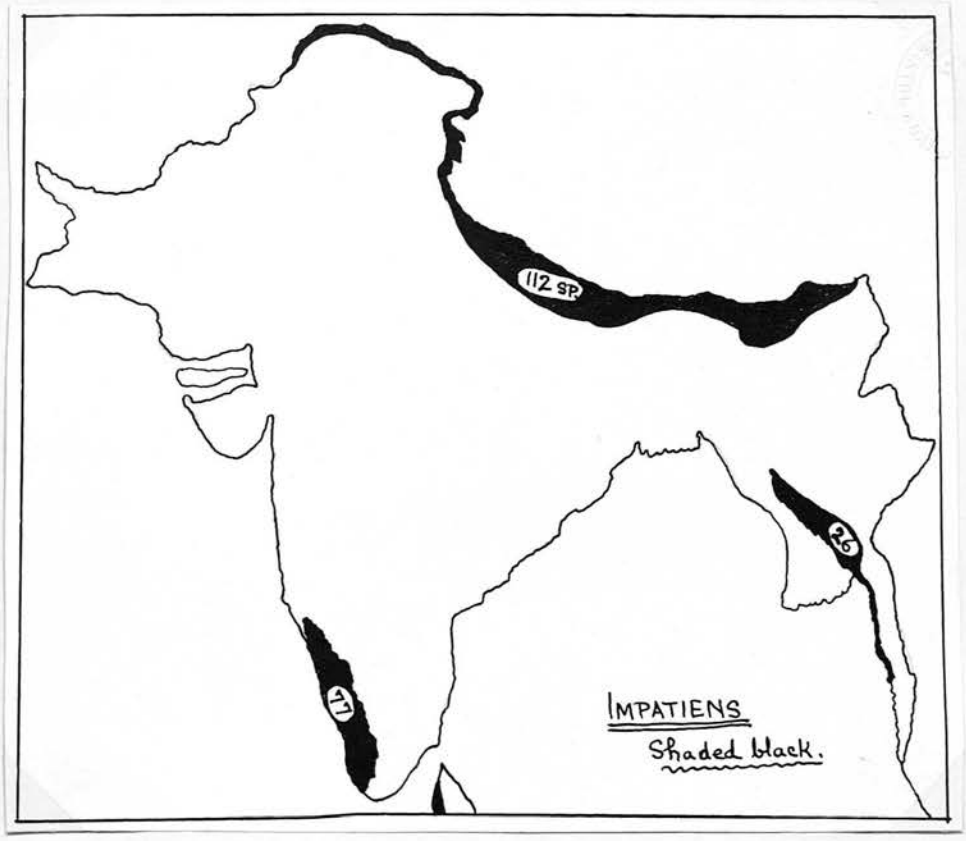
This family contain two genera Impatiens, and Hydrocera. The genera are strongly contrasted as regards number of species. Impatiens contains about 550, and Hydrocera is represented by only one species (H. Angustifolia, Bl.) found widely in the Asiatic tropics as well as in India.

The genus Impatiens has its greatest develop-:ment in the Indian region and is found chiefly in moist subtemperate areas. The greatest concentra-:tion of the species has taken place in the humid Eastern Himalayas and in Burma and this fact natur-:ally leads us to believe that the genus is a northern one. But it is very striking that a great assemblage of species is also found in Southern India and Ceylon. The intermediate regions of the Indus Plain and the Gangetic Plain completely lack species of Impatiens. The strong development in South India is thus an interesting example of dis-:continuity. Here we have a case where not even one species is common to the Himalayas and South India although each of these areas contains a very large number of endemic species. In this case the study of endemism of the Indian species shows that the two groups (i.e. the Himalayan and South Indian) must have been separated from each other for a very long time, and have developed along parallel lines each /

each producing its own set of endemic species.

The total number of endemic species in India is 220 out of 241, which brings the endemic percentage to 91. Moreover the genus is the largest as to number of species in the Indian area. In his detailed study of the genus Hooker expected that it would prove to be so (Rec. Bot. Surv. Ind. Vol.IV. 1904-6) and to-day it is clear that his surmise was a correct one.

The relationship of the Indian members is rather difficult to ascertain. The South Indian group of 77 species are closely connected with the 15 species from Ceylon, and has little or no relationship with the Himalayan group. Few of the central and lower Burma species of Impatiens have their allies in Siam and Malaya. It seems quite likely that the genus Impatiens is one of the very old plant groups of India, with three separate and independant centres of development as shown by the following map.



Celastraceae.

Celastraceae with 84 species in the Indian region are distributed in lower hills and plains of Continental India, Ceylon, Assam, Eastern Himalaya and Burma, with high concentration of species in South India and South Burma. The endemic figure for the family is 71 percent.

Some of the genera show high endemism such as Euonymus with 27 species endemic out of 32, bringing the endemic percentage to 84. The majority species /

species of Gymnosporia are endemic in South India and the Eastern Himalaya. Lophopetalum and other genera occur both in Burma and South India - evidence of a definite link between the floras of these two regions. Except perhaps for Euonymus and Celastrus which are in temperate areas the relationship of the others seems strongly with Malayasian plants.

Papilionaceae.

This is the largest family of Dicotyledons in India. The total number of species is as high as 867 including 372 "wides". The endemic percen-:tage for the family is 57 percent.

The family embraces plants of varied habit and diverse tendencies. Thus species of Dalbergia with their lofty tree habit contrast strongly with the small herbaceous species found in the Himalayas.

In the Indian region genera like Crotalaria and Tephrosia have their greatest development in South India. Millettia has the strongest develop-:ment in Assam and North Burma where as many as 16 species are found as endemics. Caragana and Astragalus on the other hand have developed strongly in the dry western Himalayas. The endemic percen-:tage of Astragalus in the Himalayas is 75 and most of /

of the species are found at high altitudes.

It seems clear from above that in India the genera of Papilionaceae are distributed in very distinct areas and have developed freely there. This would suggest that the family has reached India from many sources and we find that its associations tend to confirm this. The family affects chiefly the drier regions and there is usually a marked diminution when we come to areas of heavy rainfall. The Assam and the Burmese species show relationship with South East Asia, the Hima-:layan with West and North Asia, while the South and West Indian species connect with the Orient and North Africa. This result is only to be expec-:ted.

Rosaceae.

In India Rosaceae are mainly distributed in the temperate regions of the Himalayas and other mountains. The total number of species is 257 which include 179 endemic species. The endemic percentage for the family is 70. Most of the species are found in alpine regions of the Hima-:layas. The distribution of species is rather poor in South India, Burma and the Indo-Gangetic plain.

As /

As a family Rosaceae undoubtedly belongs to the Northern Flora. A continuous distribution may be traced throughout Europe, the Orient, Northern and Western Asia, the Himalayas, North Burma and China. The representative genera of the north--western side are Prunus, Rubus, Rosa, Potentilla, Cotoneaster and Pyrus while those of the eastern side are Eriobotrya, Photinia, and Pygeum.

Saxifragaceae.

The most important genus in this family is Saxifraga the species of which are found chiefly in the temperate and alpine parts of the Eastern Himalayas. Of the 58 species of Saxifraga 51 are endemic, giving a percentage of 88 for the genus. Most of the species occur in the drier parts of Sikkim in the alpine regions adjoining the Tibetan frontier. The genus is not found in our area outside the Himalayas. The association of the Himalayan species is chiefly with the North and with China on the east.

The general endemic figure for the family is 76 percent, (87 species being endemic out of 114 species.)

The relationships of this family follow similar /

similar lines to those of the major northern groups showing the influence of temperate North and East Asia.

P.T.O.

Rubiaceae.

This is one of the largest families of Dicotyledons, and is well represented in Continental India, Burma, Assam and the subtemperate regions of the Himalayas. The main centre and development of this family for the area under review is undoubtedly in South India (and Ceylon) and Southern Burma. There are 551 species of Rubiaceae in India of which 364 are endemics, thus bringing the percentage to 67. The majority of the 187 species of "Wides" are found in Malayasia.

Six of the genera of Rubiaceae are wholly endemic in the Indian region (see appendix I) while others contain a high majority of endemics. The distribution of the leading genera in India is indicated below:-

Wendlandia - 19 sp - 13 endemic -
- 4 in E. Himal.
- 5 in S. India.
- 1 in Burma.

Oldenlandia - 75 sp - 51 Do. ⟶ Mostly in Deccan.

Anotis - 17 sp - 15 Do. ⟶
- 5 in Assam and Trop. E. Himal.
- 10 in Deccan

Ophiorrhiza - 36 sp - 31 Do. ⟶
- 17 in Assam and Himal
- 9 in Deccan
- 4 in Burma.

Ixora - 57 sp - 39 endemic - { 10 in Deccan ; 25 in Burma }

Pavetta - 32 sp - 25 Do. → { 19 in Deccan ; 4 in Burma }

Psychotria - 34 sp - 27 Do. → { 5 in Assam and Himal ; 16 in S. India. }

From the above it seems clear that the main concentration of Rubiaceae is in South India and in the tropical rainforests of Assam and lower Burma. The genus Ixora has its best development in South Burma and this is balanced in South India by the many species of the allied genus Pavetta.

The Indian relationships of this family are strongly with the Malayasian flora.

Compositae.

The family Compositae with 696 species in India is one of the dominant groups of our flora but about half of the total number of species (330) has been found as "wides." This brings down the endemic percentage to 52 - a comparatively low figure. The distribution of species ranges from tropical region to the high alpines and in their specific content South India and the Himalayas are approximately equivalent. Burma is poor in its species of Compositae. Some genera worthy of comment are as follows:-

(i) Saussurea - 41 species - 37 endemic - All in Himalayas

(ii) Aster - 20 sp. 15 Do. - All in Himalayas.

(iii) Senecio - 76 sp. 57 Do. (37 in Himalayas. 16 in S. India 3 in Burma.

(iv) Anaphalis - 30 sp. 25 Do. (13 in Bimalayas 12 in S. India.

(v) Vernonia - 56 sp. 35 Do. (2 in Himal. 24 in S. India 7 in Burma.

(vi) Centratherum - 8 sp. 7 Do. All in S. India

It will be evident from the foregoing that South India has a strong concentration of some temperate genera though it lacks the high alpines like Aster and Saussurea.

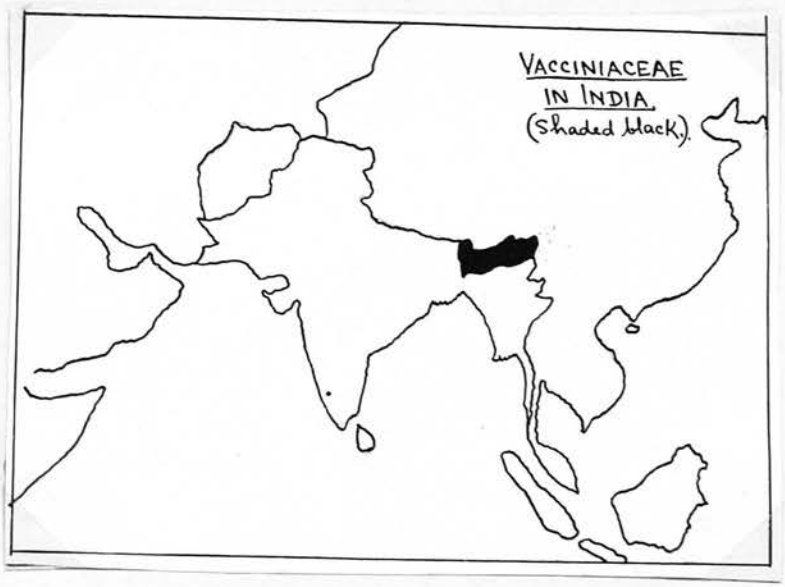
The association of the South Indian Compositae is undoubtedly with the Orient and Africa and there is little evidence of linkage with the Himalayas or with Burma. The intervening plains show few compositae and these are chiefly "wides", and associated with cultivation. The Himalayan genera are in almost every case well-known constituents of the Northern Flora as found in North Asia and China.

The great adaptability of the seeds for dispersal has made it possible for the members of this family to be distributed through a very large area which explains the great number of "wides" in the flora.

The South Indian development is further emphasised by the occurrence of five endemic genera (see Appendix I), while specialisation in the Himalayas has given but one endemic genus.

Vacciniaceae.

The greatest development of this family in the Indian area is to be found in the Eastern Himalaya, Assam and Burma. 64 species are endemic out of a total of 68, which brings the endemic percentage to the remarkably high value of 94. The most important genus is Agapetes. The Indian and Burmese species are related to the species in West China and this is quite in conformity with the distribution of Ericaceae of which family the Vacciniaceae are usually regarded as an offshoot.



P.T.O.

Ericaceae.

The most important genus of this family is Rhododendron. The species of this genus are nearly always found in the temperate and alpine zones of the mountain regions in our area. They are most abundant in the eastern Himalayas and are frequent in North Burma. They extend however to the N.W. Himalaya, to the Khasia and even to the Nilgiris. The total number of species in our record is 126 as compared with 43 described in the Flora of British India. The main additions have come from Upper Burma and from Bhutan.

At one time the Himalaya was regarded as the chief centre of the genus, but recent exploration has shown that the Western Provinces of China con-:tain the largest assemblage of species. The Indian species show a close affinity with the Chinese species although very few are common to both areas. The number of endemic species in the Himalayas is 64 and in Upper Burma 44. This gives a high endemic ratio of 90 percent, and this indicates that the species though closely allied to the Chinese ones are in most cases quite distinct.

Primulaceae.

The two chief genera are Primula and Androsace and these are confined in their distribution /

distribution to the northern Hemisphere with one or two exceptions. In our area they occur chiefly in the Himalaya but have several representatives in Upper Burma and the Khasia Hills. It is clear from the analysis that Primula has the greatest development in the moister eastern Himalaya, while Androsace is more prominent in the dry north west Himalayas. Of the two much the largest is Primula with 162 species. Of these 148 are believed to be endemic and thus the percentage is the high figure of 91. As is the case with Rhododendron, the chief assemblage of species of this genus is to be found in the Western provinces of China, and the great majority of the Indian species find their nearest allies in the Chinese flora. Evidence of this is readily given by such species as P. capitata, P. denticulata and P. involucrata. The species from the north west Himalayas indicate a certain degree of association with the northern Asia as suggested by such species like P. sibirica and P. nivalis. One or two species from the dry north west Himalayas are closely linked with species in Persia, Arabia and Abyssinia. But there is no doubt that the main association is with the species of China and this is particularly true of the north Burmese plants which are nearly all concen-
:trated near the Chinese border - most of them
are /

are Chinese plants which have crossed from China into the adjoining Burmese mountains. It may also be noted that in the Himalayas there are more species of Primula than any other area in the world except West China.

There is one interesting monotypic genus Bryocarpum - at one time presumed to be endemic in the eastern Himalayas, but it has recently been recorded from South East Tibet. Another genus Omphalogramma has a restricted geographical range being found only in the eastern Himalayas with 2 species and also in the West China and Burma where there are some 6 additional species.

Asclepiadaceae.

Asclepiadaceae is a family represented in India chiefly from the Deccan Peninsula and the foothills of the Himalayas. The total number of species in our record is 234 of which 172 are endemic, thus bringing the endemic value to 73 percent. These species belong to 49 genera and so most of the genera can contain but few species. Of the genera 10 are found to be endemic.

Mention may be made of genera like Caralluma Hoya, and Ceropegia. Caralluma is a genus of special interest as in our area it has developed in a marked degree only in the dry parts of the Deccan and western India. Of the 12 species all are endemic except 3 which are also found in the dry regions of Persia. The greatest development of the genus is in Africa and Madagascar - and here without any doubt the relationship of the Indian species is strongly with Africa (quite possibly via the Orient) and this is perhaps one of the very few examples of a definite African element in our flora.

Ceropegia has 40 species in India and this genus as a whole is also strongly developed in South India (where 26 species are found as endemic). Only 3 species are found in the subtropical regions of /

of the Himalayas and 2 occur in Burma.

A contrasting genus for Ceropegia is perhaps Hoya where out of 30 species 22 are found as endemic in the Himalayas and Burma and only 3 in South India.

Such pairs of genera tend to counterbalance the general distribution of endemic species of a family. If we take the above particular genera and consider restricted areas the endemic index is naturally high but Asclepiadaceae as a whole for the total area shows but a moderate degree of endemism (i.e. 73 percent).

Gesneriaceae.

The members of this family which occur in Eastern Asia are remarkable for their very restric-:ted distribution of the individual species. Only one or two have anything like a wide range. The species are found chiefly in the subtropical regions of the east Himalayas, Khasia Hills, Burma, and Malayasia. Most of the species occur at moderate elevations in the moister hills (3000 to 5000 feet). The only exception is perhaps species of Didissandra which are found at much higher altitudes.

The general endemic percentage for the family is 92, which is very high for a subtropical family and is in accord with the restricted specific range, already mentioned. Of a total of 133 species 122 are found endemic in the Indian area. About 100 species occur in East Himalaya, Assam and Burma and only 14 in the Nilgiris. The high endemicity is also emphasised by the presence of 7 endemic genera out of 27.

The relationship of the family is undoubtedly with Malayasia and it is quite possible that the Indian Gesneraceae have come in great part from S.E. Asia.

Acanthaceae. /

Acanthaceae.

The family Acanthaceae contains a very large number of species in India - 514. They occur chiefly in the tropical and subtropical regions of our area and are particularly abundant in the Deccan Peninsula where as many as 188 species are endemic.

The general endemic figure for the family is 82 percent which is very high for a tropical family. This high endemicity is readily seen in Strobilanthes where 146 species are endemic out of a total of 152. This is one of the largest genus in India. Other genera of interest are:-

(i) Staurogyne, Wall. - 22 sp - 18 endemic.
- 1 Himalaya
- 1 Continental India
- 11 Burma.

(ii) Stenosiphonium Nees. 5 sp - 5 endemic. — All in S. India

(iii) Barleria, Linn - 24 sp - 16 endemic. — 15 in S. India

(iv) Andrographis, Wall - 23 sp - 18 endemic. — All in S. India

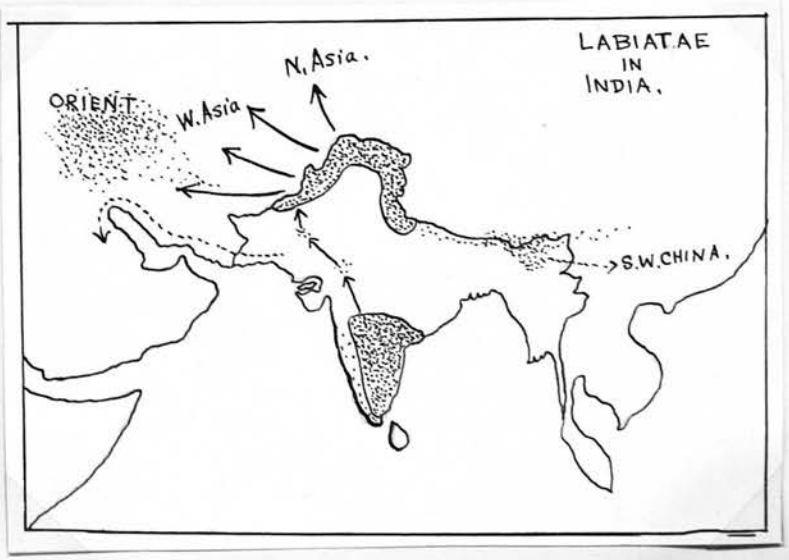
(v) Phlogacanthus, Nees - 10 sp - 10 endemic.
- 8 in Himalaya
- 1 in S. India
- 1 in Burma.

The /

The number of endemic genera in India is 14, out of a total of 50. This suggests that India is probably one of the best regions for the develop-:ment of Acanthaceae.

Labiatae.

The family Labiatae is represented in India by 421 species in 69 genera. Of these 261 are endemic and the percentage is 62. The members of the Labiatae inhabit comparatively dry areas and moderate altitudes. Very few species are found in the plains. Two centres of concentration of species may be found in our area and these are north-west India, and the Deccan. These two regions are linked through Sind and Beluchistan and the general relationship of these areas are to be found with the drier Orient and North Western Asiatic flora (shown by the diagram below)



The very moist parts of India contain but a few species and mention may be made of species of Gomphostemma and Mesona, found in Assam and North Burma. These can be linked with other species found in the eastern Himalayas - another area of heavy rainfall.

The South Indian development of Labiatae is very remarkable and a possible parallel to such a strong concentration of a Northern family in this region is found in Balsaminaceae (Impatiens). But Balsaminaceae have developed in Malabar - the moist half of the Peninsula - while Labiatae on the other hand have multiplied mostly in the eastern dry part - the Deccan.

The general endemic figure for the family seems to be rather low, but the endemicity is high in some of the genera shown in the following list:

(a) Plectranthus - 37 sp - 31 endemic. { 12 in Himalayas; 12 in Cont. India; 6 in Burma }

(b) Anisochilus - 14 sp - 12 endemic. { 2 in Himal; 10 in Cont. India; 7 in Himalaya }

(c) Pogostemon - 27 sp - 23 endemic. { 15 in Cont. India; 1 in Burma. }

(d) Nepeta -
42 sp - 26 endemic. { 25 in W. Himalaya
1 in Cont. India.

(e) Leucas -
42 sp - 28 endemic. { 24 in Cont. India.
4 in Burma.

(f) Elsholtzia -
14 sp - 10 endemic. { 8 in Himal
2 in Burma.

(g) Salvia -
23 sp - 11 endemic { 10 in Himal
1 in Burma.

(h) Dracocephalum -
9 sp - 7 endemic. All in Himalayas.

(i) Phlomis -
10 sp - 6 endemic { 5 in Himal
1 in Burma.

(j) Gomphostemma -
22 sp - 16 endemic. { 9 in Himal
2 in Cont. India
5 in Burma.

It will be clear from the above that genera like (b), (c), (e), are strongly represented in the Continental India and conversely (d), (f), (g), (h), (i) in the Himalayas.

The relationship of the Indian Labiatae is in the main with the species occurring in the Orient. A moderate influence from China and Malayasia is also responsible for some of the species in Assam and Burma.

Polygonaceae.

A complete account of the Indian species of Polygonum has been made by Gage in Rec. Bot. Surv. Ind. II.5. 1903. This genus with 88 species in our area is by far the most important representative of the family. There are two striking facts about the species. The first is the high endemism shown by almost all the species found in the hills, and secondly the great range of altitude covered by some species. The member showing the greatest vertical range is Polygonum viviparum. L. which is found from 5,000 to 18,000 feet. As a contrast other species such as P. perpusillum Hook. f. and P. Hookeri, Meissn, have a very restricted range in the Himalayas.

78 species are endemic in India out of a total of 88 which brings the endemic value to 88 percent. The "wides" mostly come from the side of Persia and Afghanistan. The chief distribution of Polygonum is definitely in the dry regions of the Western Himalayas and other mountains and as we approach Burma and the S.E. Asia the species diminish rapidly in number.

Loranthaceae.

This family of semi-parasitic plants are found /

found distributed chiefly in the tropics of the whole world. The greatest development in the eastern Hemisphere has undoubtedly taken place in the Malayasian region where numerous species have been reported. Of the 73 species in the Indian region only 47 are found to be endemic which brings the percentage to 64. The species are mainly found in Malabar, and moist rainforest of Assam. The association of these are to be found with the species from Malaya, Sumatra, Java and Borneo.

Euphorbiaceae.

Owing to its wide distribution in the tropi-:cal and subtropical regions the family Euphorbi-:aceae has a moderate endemicity in India - only 63 percent. The major concentration of species has taken place in the Deccan peninsula where they grow well in warm and dry localities. Burma and the Himalayas - both moist areas, are equivalent in their endemic contents and have comparatively few species.

The widespread and well characterised genus Euphorbia shows a strong representation in India where 41 species have been found to be endemic out of a total of 63. Here the number of species seems to /

to be equally balanced between Continental India and the Himalayas. It is further interesting to note that in the Himalayas the species are found at high altitudes, even in the alpine zone and resemble the species of northern Asia. Most of the species of the Deccan and West India are fleshy like Cacti, and show therefore a relationship with those of the Orient and Africa.

The number of genera in our area is 70 and of these only five are endemic.

IX. Summary.

(i) The present paper attempts to survey the nature of endemism among Indian Dicotyledons in a detailed manner, as similar work has not been previously done. The distribution, relationship and other features of interest in the Indian species have been indicated in a commentary in section VIII.

(ii) The total number of species is 11,124 (approximately), of which 61.5 percent is endemic and the rest 38.5 percent occur in our area as "wides." The endemic species have been found in high concentration in three regions, (a) The Himalayas, (b) South India, and (c) Burma.

(iii) A complete catalogue of the Indian Dicotyledons has been made showing the present distribution and modern nomenclatural changes for each species. This forms a separate volume of 527 pages.

(iv) It was further necessary to modify the existing Phyto-geographical map of India, previously made by Clarke (1898) and Hooker (1909). The modified arrangement is shown on page 11.

(v) A discussion on the present dominant genera and families of India has been made in section VII. which shows some interesting changes within the last 30 years.

APPENDIX I.

List of endemic genera from India and Burma.

Papaveraceae -	
Cathcartia Hook. f. (Reduced to Meconopsis, Vig by G. Taylor in his monograph. 1934.)	E. Himalaya
Cruciferae -	
Lepidostemon Hook. f. & T.	E. Himalaya (Sikkim).
Arcyosperma, Schultz.	E. & W. Himalaya
Douepia, Camb.	S.W. Punjab
Capparidaceae -	
Hypselandra Pax et Hoffmann (Fedde Repert. XLI (1936) 128)	Burma
Borthwickia, W.W. Smith (Trans. Proc. Bot. Soc. Edin. XXIV (1911) 175)	Burma (Upper)
Flacourtiaceae -	
Gynocardia R. Br.	E. Himal, Assam, Burma, Chittagong.
Guttiferae -	
Poeciloneuron, Bedd.	S. India (Malabar).
Malvaceae -	
Decaschistia, W. & A.	S. India.
Sterculiaceae -	
Mansonia, Drumm .	Burma (Lower)

Tiliaceae -	
Erinocarpus Nimmo	S. India
Plagiopteron, Griff.	Burma (Lower)
Linaceae -	
Anisadenia, Wall	C.& E. Himalaya, Khasia. Now found in extreme South China
Rutaceae -	
Chloroxylon DC.	S. India (Nilgiri, Ceylon)
Meliaceae -	
Beddomea Hook. f.	S. India (Malabar).
Sapindaceae -	
Otonephelium, Radlk.	S. India (Malabar).
Zollingeria, Kurz	Burma (Lower)
Anacardiaceae -	
Solenocarpus, W. & A.	S. India (Malabar).
Drimycarpus, Hook. f.	E. Himalaya (Sikkim), Khasia.
Nothopegia Bl.	S. India (Malabar, Ceylon).
Papilionaceae -	
Stracheya, Benth.	C. Himalaya, Tibet.
Neocollettia, Hemsl.	Burma.
Ougeinia, Benth.	W. Himalaya, S.W. Punjab.
Dicerma, DC.	Burma.
Phyllodium, Desv.	Burma.
Cateneria, Benth.	Burma.
Cochlianthus, Benth.	C. Himalaya.
Butea (Roal) Koen.	India, Burma.
Mastersia, Benth.	E. Himalaya, (Mishmi Hills).

Caesalpinaceae -	
Wagatea, Dalz.	S. India (Malabar)
Rhizophoraceae -	
Blepharistemma, Wall.	S. India (Malabar).
Myrtaceae -	
Meleoromyrtus, Gamble	S. India (Malabar).
Cucurbitaceae -	
Biswarea, Cogn. (Syn. Warea, Clarke)	E. Himal (Sikkim).
Dicaelosperma, Clarke	S. India (Malabar).
Edgaria, Clarke	E. & W. Himalaya.
Umbelliferae -	
Vicatia, DC.	E. & W. Himalaya.
Meeboldia, Wolff	W. Himalaya.
Polyzygus, Dalz.	S. India (Malabar).
Pleurospermopsis, Norman.	E. Himalaya (Sikkim)
Cortia, DC.	E. & W. Himalaya.
Araliaceae -	
Pentapanax, Seem.	India.
Woodburnia, Prain.	Burma.
Gamblea, Clarke	E. Himalaya (Sikkim)
Tupidanthus, Hook. f.	Khasia.
Cornaceae -	
Torricella, DC.	E. & W. Himalaya.
Caprifoliaceae -	
Pentapyxis Hook. f.	E.Himalaya (Sikkim)
Rubiaceae -	
Clarkella, Hook. f.	W. Himalaya.
Polyura, Hook. f.	Khasia, E. Himalaya (Mishmi).

Rubiaceae - (contd.)	
Parophiorrhiza, Clarke	Khasia.
Carlemannia, Benth.	E. Himalaya (Sikkim), Khasia.
Silvianthus, Hook. f.	Khasia, (Sylhet).
Octotropis, Bedd.	S. India (Malabar).
Valerianaceae -	
Nardostachys, DC.	E. & W. Himalaya. Also recently recorded from South China.
Compositae -	
Lamprachaenium, Benth.	S. India (Malabar).
Adenoon, Dalz.	S. India (Malabar).
Nanothamnus, Thoms.	S. India (Malabar).
Caesulia, Roxb.	Punjab, Chittagong, Deccan.
Glossocardia, Cass.	C. India, & S.India.
Goniocaulon, Cass.	C. India & S. India.
Catamixis, Thoms.	W. Himalaya.
Campanulaceae -	
Leptocodon Hook. f. & T.	E. Himalaya. Now recorded from South China.
Vacciniaceae -	
Pentapterygium, Klotzsch	E. Himalaya (Sikkim) Khasia.
Corallobotrys, Hook. f.	Khasia, E. Himalaya (Bhutan).
Ericaceae -	
Diplarche, Hook. f. & T.	E. Himalaya (Sikkim)

Pyrolaceae -	
Cheilotheca, Hook. f.	Khasia.
Primulaceae -	
Bryocarpum, Hook. f. & T.	E. Himalaya (Sikkim to Mishmi).
Myrsinaceae -	
Sadiria, Mez	E. Himalaya (Bhutan), Khasia.
Antistrophe, A.DC.	S. India (Malabar, 1 sp.), Khasia (1 sp.)
Hymenandra, A. DC.	Assam.
Amblyanthus, A. DC.	Khasia.
Amblyanthopsis, Mez	E. Himalaya (Bhutan), Assam.
Styracaceae -	
Parastyrax, W.W. Smith	Burma (Upper)
Asclepiadaceae -	
Brachylepsis, W. & A.	S. India (Nilgiri)
Utleria, Bedd.	S. India (Deccan)
Decalepsis, W. & A.	S. India (Deccan)
Pentabothra, Hook. f.	Assam (Kamrup)
Adelostemma, Hook. f.	Burma.
Lygisma, Hook. f.	Burma.
Treutlera, Hook. f.	E. Himalaya (Sikkim).
Dittoceras, Hook. f.	E. Himalaya (Sikkim).
Oianthus, Benth.	S. India (Deccan)
Frerea, Dalz.	S. India (Malabar).
Gentianaceae -	
Parajaeschkea, Burkill.	E. Himalaya (Sikkim).

Gentianaceae - (contd,)	
Jaeschkea, Kurz.	E. & W. Himalaya Now recorded from S. China.
Boraginaceae -	
Lacaita, Brand	E. Himalaya (Sikkim), Burma (Upper)
Actinocarya, Benth.	E. & W. Himalaya, Tibet.
Microula, Benth.	Himalaya & Tibet.
Convolvulaceae -	
Blinkworthia, Choisy.	Burma.
Scrophulariaceae -	
Bythophyton, Hook. f.	Khasia.
Hemiphragma Wall.	E. Himalaya, Khasia, Burma. Now recorded from S. China.
Picrorhiza, Royle	E. & W. Himalaya.
Oreosolen, Hook. f.	E. Himalaya (Sikkim)
Falconeria, Hook. f.	W. Himalaya.
Gesneraceae -	
Platystemma, Wall.	W. Himalaya.
Boeica, Clarke	E. Himalaya, Burma (Upper)
Tetraphyllum, Griff.	Assam, & Chittagong.
Trisepalum, Clarke	Burma (Lower).
Phyllobcea, Clarke	Burma (Lower)
Jerdonia, Wight.	S. India (Deccan)
Leptobcea, Benth.	E. Himalaya (Sikkim, Mishmi Hills), Khasia.

Acanthaceae -	
Ophiorrhizophyllon, Kurz.	Burma (Lower)
Meyenia, Nees.	S. India (Deccan)
Petalidium, Nees.	S.W. Punjab and S. India.
Aechmanthera, Nees.	E. & W. Himalaya.
Stenosiphonium, Nees.	S. India
Calacanthus, Anders.	S. India (Malabar).
Phlogacanthus, Nees.	Himalaya, Assam, Burma.
Diotacanthus, Benth.	S. India (Malabar).
Cystacanthus, Anders.	Burma.
Haplanthus, Nees.	S. India (Malabar), Burma.
Asystasiella, Lindan.	Khasia.
Phialacanthus, Benth.	N. Assam.
Odontonemella, Lindan.	Khasia.
Sphinctacanthus, Benth.	Assam.
Labiatae -	
Craniotome, Reich.	E. & W. Himalaya, Khasia.
Eriophyton, Benth.	E. & W. Himalaya.
Roylea, Wall.	W. Himalaya.
Notochaete, Benth.	E. Himalaya, Burma.
Amarantaceae -	
Banalia, Moq.	S. India.
Stilbanthus, Hook. f.	E. Himalaya (Sikkim), Khasia.
Podostemaceae -	
Griffithella, Warming.	S. India (Malabar)

Podostemaceae - (contd.)	
Willisia, Warming.	S. India (Nilgiri)
Cytinaceae -	
Sapria, Griff.	E. Himalaya, (Mishmi Hills).
Lauraceae -	
Syndichis, Hook. f.	E. Himalaya (Bhutan).
Purkayasthea, Purkayastha.	Khasia.
Dodecadenia, Nees.	Himalaya, Assam, Burma.
Loranthaceae -	
Helicanthes, Danser.	S. India.
Santalaceae -	
Phacellaria, Benth.	Manipur and S. Burma.
Euphorbiaceae -	
Pseudoglochidion, Gam-:ble.	S. India (Malabar).
Neopeltandra, Gamble	S. India (Malabar)
Prosorus, Dalz.	S. India (Malabar)
Platystigma R. Br.	Assam.
Lasiococca, Hook. f.	E. Himalaya (Sikkim)

APPENDIX II.

Table showing the numbers of endemic and Non-endemic species of Indian Dicotyledons in each family.

Families.	Total Sp.	Total Gen.	Wides. W.	←ENDEMIC→ Cont. Ind.	H. (Himalaya)	B. (Burma)	G.-Area.
Ranunculaceae	162	21	61	13	80	5	3
Dilleniaceae	15	3	10	3	0	1	1
Magnoliaceae	36	7	5	0	24	6	1
Schizandraceae	5	2	4	0	1	0	0
Anonaceae	129	22	52	28	11	29	9
Menispermaceae	42	17	30	6	4	1	1
Lardizabalaceae	5	4	1	0	4	0	0
Berberidaceae	35	4	1	1	28	3	2
Nymphaeaceae	11	6	7	3	0	0	0
Cruciferae	174	43	78	8	86	0	2
Fumariaceae	66	4	18	0	47	1	1
Papaveraceae	43	7	15	0	25	3	0
Capparidaceae	65	10	30	18	2	12	3
Resedaceae	4	3	4	0	0	0	0
Violaceae	25	3	14	1	7	3	0
Bixaceae	1	1	1	0	0	0	0
Cochlospermaceae	1	1	1	0	0	0	0
Flacourtiaceae	21	5	10	4	1	3	3
Pittosporaceae	8	1	4	2	2	0	0
Polygalaceae	32	4	25	4	1	2	0
Xanthophyllaceae	7	1	5	1	1	0	0
Frankeniaceae	1	1	1	0	0	0	0
Caryophyllaceae	107	18	44	2	57	1	3
Portulacaceae	6	2	5	1	0	0	0
Tamariscaceae	8	2	4	2	1	0	1
Elatinaceae	6	2	5	1	0	0	0
Hypericaceae	26	3	11	1	11	1	2
Guttiferae	40	6	20	13	3	4	0
Ternstroemiaceae	39	13	18	8	7	4	2
Dipterocarpaceae	51	8	16	15	2	17	1
Ancistrocladaceae	5	1	4	1	0	0	0
Malvaceae	111	22	81	18	4	6	2
Sterculiaceae	80	19	47	18	9	5	1
Tiliaceae	78	9	42	21	4	6	4
Elaeocarpaceae	42	2	27	4	7	3	1
Linaceae	8	5	5	0	3	0	0
Erythroxylaceae	6	1	5	0	1	0	0
Malpighiaceae	17	2	10	2	4	0	1
Zygophyllaceae	9	5	9	0	0	0	0
Geraniaceae	28	4	16	0	11	0	1

Oxalidaceae	14	3	9	3	2	0	0
Balsaminaceae	242	2	21	77	112	26	6
Rutaceae	71	24	48	9	7	5	2
Simarubaceae	15	7	11	1	3	0	0
Ochnaceae	9	2	5	3	0	1	0
Burseraceae	13	5	3	9	0	0	1
Meliaceae	62	19	27	17	11	4	3
Dichapetalaceae	3	1	3	0	0	0	0
Olacaceae	18	6	13	2	2	0	1
Icacinaceae	25	12	7	10	2	5	1
Opiliaceae	4	3	3	0	0	1	0
Aquifoliaceae	34	1	21	3	4	4	2
Celastraceae	84	10	24	22	22	10	6
Hippocrateaceae	27	3	13	6	5	2	1
Rhamnaceae	53	11	25	10	15	2	1
Ampelidaceae	70	8	31	18	13	1	7
Leeaceae	27	1	6	5	3	3	10
Staphyleaceae	4	2	3	1	0	0	0
Hippocastanaceae	2	1	2	0	0	0	0
Sapindaceae	54	20	34	7	3	8	2
Aceraceae	20	1	3	0	15	2	0
Sabiaceae	19	2	5	1	10	1	2
Anacardiaceae	67	20	25	20	8	9	5
Coriariaceae	1	1	1	0	0	0	0
Connaraceae	20	5	11	3	1	4	1
Papilionaceae	862	112	372	176	147	108	59
Caesalpiniaceae	125	23	78	21	5	15	6
Mimosaceae	96	17	53	26	6	9	2
Rosaceae	255	26	76	14	144	11	10
Saxifragaceae	114	17	27	0	83	4	0
Crassulaceae	64	7	15	4	44	1	0
Droseraceae	4	2	4	0	0	0	0
Hamamelidaceae	7	7	3	0	4	0	0
Halorrhagidaceae	14	5	10	3	0	0	1
Rhizophoraceae	16	9	15	1	0	0	0
Combretaceae	49	6	26	11	1	9	2
Hernandiaceae	4	2	2	2	0	0	0
Myrtaceae	116	9	59	44	4	4	5
Lecythidaceae	12	2	7	1	0	4	0
Melastomaceae	127	16	42	48	16	17	4
Lythraceae	48	7	26	15	2	4	1
Crypteroniaceae	3	1	1	0	1	1	0
Sonneratiaceae	5	2	4	0	0	0	1
Onagraceae	39	6	13	2	24	0	0
Samydaceae	20	2	9	5	2	1	3
Passifloraceae	7	2	4	0	3	0	0
Caricaceae	1	1	1	0	0	0	0
Turneraceae	1	1	1	0	0	0	0
Cucurbitaceae	86	28	58	12	9	2	5
Begoniaceae	71	1	16	7	26	18	4
Dasticaceae	2	2	2	0	0	0	0
Cactaceae	6	3	6	0	0	0	0
Aizoaceae	16	7	16	0	0	0	0
Umbelliferae	180	43	49	23	101	4	3

Araliaceae	55	15	23	7	20	4	1
Alangiaceae	6	1	4	0	1	1	0
Cornaceae	12	5	8	1	3	0	0
Nyssaceae	2	1	1	0	0	1	0
Caprifoliaceae	56	8	13	2	39	0	2
Rubiaceae	555	68	187	170	101	66	31
Valerianaceae	20	4	4	6	10	0	0
Dipsaceae	17	4	3	1	12	1	0
Compositae	697	126	330	102	219	23	23
Stylidaceae	3	1	3	0	0	0	0
Goodeniaceae	2	1	2	0	0	0	0
Campanulaceae	71	13	24	4	38	4	1
Vacciniaceae	68	4	4	1	39	21	3
Ericaceae	144	9	18	0	78	44	4
Monotropaceae	3	3	2	0	1	0	0
Diapensiaceae	1	1	0	0	1	0	0
Plumbaginaceae	8	6	5	2	1	0	0
Primulaceae	208	7	31	2	159	16	0
Myrsinaceae	92	10	29	12	37	9	5
Sapotaceae	32	10	14	10	4	3	1
Ebenaceae	58	2	18	18	11	10	1
Symplocaceae	51	1	7	23	14	6	1
Styraceae	9	3	3	0	3	3	0
Oleaceae	97	10	29	25	23	16	4
Salvadoraceae	5	3	5	0	0	0	0
Apocynaceae	84	36	30	17	14	17	6
Asclepiadaceae	232	49	62	73	61	19	17
Loganiaceae	40	8	20	3	9	3	5
Gentianaceae	188	15	42	24	89	28	5
Menyanthaceae	1	1	1	0	0	0	0
Polemoniaceae	1	1	1	0	0	0	0
Hydrophyllaceae	1	1	1	0	0	0	0
Boraginaceae	145	39	62	27	47	4	5
Convolvulaceae	177	24	90	43	12	20	12
Solanaceae	58	14	42	7	6	0	3
Scrophulariaceae	274	54	135	22	90	16	11
Orobanchaceae	29	7	17	5	6	1	0
Lentibulariaceae	30	2	13	9	5	3	0
Gesneriaceae	133	27	11	14	66	34	8
Bignoniaceae	32	13	16	5	2	7	2
Pedaliaceae	4	2	2	2	0	0	0
Acanthaceae	508	50	88	188	107	99	26
Verbenaceae	115	15	60	18	18	8	11
Labiatae	419	69	160	81	110	28	40
Plantaginaceae	13	1	12	0	1	0	0
Nyctaginaceae	8	3	4	2	1	0	1
Illecebraceae	2	2	2	0	0	0	0
Amarantaceae	47	17	31	9	4	1	2
Chenopodiaceae	40	18	37	2	1	0	0
Phytolaccaceae	2	2	2	0	0	0	0
Polygonaceae	110	8	25	3	64	1	17
Podostemaceae	16	8	5	9	1	0	1
Nepenthaceae	1	1	0	0	1	0	0
Cytinaceae	1	1	0	0	1	0	0
Aristolochiaceae	13	3	4	3	5	1	0

Piperaceae	103	4	15	24	52	8	4
Chloranthaceae	3	2	3	0	0	0	0
Myristicaceae	14	4	5	6	1	0	2
Lauraceae	171	18	33	45	63	19	11
Hernandiaceae	1	1	1	0	0	0	0
Proteaceae	7	1	2	2	0	2	1
Thymeleaceae	22	10	12	0	7	0	3
Elaeagnaceae	12	2	4	5	3	0	0
Loranthaceae	73	13	26	24	11	9	3
Santalaceae	15	7	3	3	4	4	1
Balanophoraceae	6	2	1	0	4	0	1
Buxaceae	6	2	2	1	2	1	0
Euphorbiaceae	442	70	161	119	74	68	20
Ulmaceae	16	5	10	1	1	2	2
Cannabinaceae	2	2	2	0	0	0	0
Moraceae	114	15	70	10	14	8	12
Urticaceae	111	20	42	10	43	7	9
Plantanaceae	1	1	1	0	0	0	0
Juglandaceae	4	2	4	0	0	0	0
Myricaceae	1	1	1	0	0	0	0
Casurinaceae	1	1	1	0	0	0	0
Cupuliferae	64	7	22	2	19	9	12
Salicaceae	43	2	14	0	28	0	1
Ceratophyllaceae	1	1	1	0	0	0	0

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